[ESTABLISHED 1832]
THE OLDEST RAILROAD JOURNAL IN THE WORLD

AMERICAN ENGINEER AND RAILROAD JOURNAL.

PUBLISHED MONTHLY
BY
R. M. VAN ARSDALE, INC.
140 NASSAU STREET, NEW YORK

J. S. BONSALL, Vice-President and General Manager
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407 Medinah Bldg., Chicago

MAY, 1911

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possibly every day have been carried. An instance is before us at this writing where it would be necessary to drop the rear driving wheel on a 4-6-0 engine to remove the back driving spring, no provision having been made in the design to allow sufficient space between the boiler and the driver to pull it back and out on the tender after being disconnected. In another the back motion eccentric must be removed from the axle to tighten the set screws in the forward motion, because the set screws had been located within the eccentric instead of clear of it in the extension for more bearing on the axle, where they could be readily reached with a socket wrench. On a recent consolidation engine the main air reservoir was observed to be placed behind the cylinders, and tight up against the boiler jacket, so that for its removal the heavy engine truck equalizer and the cross equalizer and its hanger must all come down

Instances of poorly located minor parts, and particularly carelessly run piping, which in many cases must have several tight joints broken to permit the simple tightening of nuts behind it, are innumerable. On a recently inspected engine we found that in order to apply a new right hand sliding fire door to the door frame it would be requisite as a preliminary to remove the reverse lever and quadrant, all piping from the engineer's brake valve, and the overflow and feed pipes from the right injector, both injectors happening to be on the back head of the boiler.

It may be that the location of these things is the result of careful consideration, and is the best that can be done under the circumstances, but instances indicating the contrary are so plentiful and so flagrant that we are inclined not to believe it. We do not think that the running repair phase of the situation is viewed at its true importance; in other words, that the location of the minor parts is frequently determined upon without reference to their easy accessibility to repair. It does not appear that those in the drawing office are familiar with running repair jobs in their order of rotation, and do not appear to have a full realization of the fact that while a part may never have to come down for any repairs to itself, it may still be removed three or four times a week to allow something else to be worked on. Thus the fatal error is easily fallen into of making these parts which are known not to require any repairs as permanent an institution on the locomotive as it is possible to do.

For instance, a dome casing never needs any repairs in the lifetime of the engine, but the dome cap which it covers sometimes has a leaky joint, and frequently has to come off for that and for work on the throttle valve. In attempting to get to it, however, the man doing the job is often confronted by a dome casing made of two pieces in this fashion: the lower section a cylinder of heavy planished iron, surmounted by a heavy, rounded cast iron top piece into which it fits with the accuracy of watch work, and is further secured by some half a dozen machine screws tapped through into the dome proper. Last, but not least, the heavy top piece mentioned has no provision for taking hold of it with a tackle, and must be handled by hand, and on a very precarious foothold, as we all know.

Of course, it is needless to add that these things, of which infinite examples abound, are decidedly wrong. They represent the combination of ignorance and lack of forethought which is a positive injustice to the roundhouse force. That the work of the latter at its best is far from being entirely agreeable needs no comment here, and these errors of judgment in the design and assembling of parts, which double the labor required for the job itself, can do nothing other than breed the spirit of discontent. That dome casing referred to would be every bit as serviceable if made of one piece, dropped over the dome, and held from moving by a tap bolt in the center of the top screwed into the dome cap.

We have had long experience with roundhouse men of all trades, and we know them to be peculiar in this way. They are perfectly willing to do any job to which assigned, but we never saw one yet who would not murmur over doing a preliminary job of greater proportions before he could get to the one he was after, and to which he had been assigned. In consequence, when that job is finally reached, the man is disgusted, and it is an even chance that the work will not be scarcely half as well done as it would have been if he could have reached it at first hand. When a road has a number of these inaccessible engines in one roundhouse it is in a truly unfortunate position from the standpoint of keeping its men satisfied and in accord with its mechanical ideas. The shop men do not like to work on these engines and they are not in sympathy with them. It may be emphasized in this connection that there is nothing which operates more to the detriment of general efficiency than the lack of sympathetic accord, whether exhibited on the road or in the shops.

These features of inaccessibility in the location of parts have gone far toward defeating and condemning many a device in possession of great intrinsic merit, and inventors as projectors of all new appliances destined for locomotive use should bear the fact prominently in mind. Judging from many devices which we have studied they are not doing so now, not at least to any extent. If it is hard to take apart or put together it will receive its sentence in the very first shop it is worked on as "no good," with, of course, the explanation why it is so designated, but unfortunately the next man will forget these reasons, and it will simply be "no good" without the redeeming explanation. Thereupon the verdict flies fast, and is too often accepted with little or no inquiry.

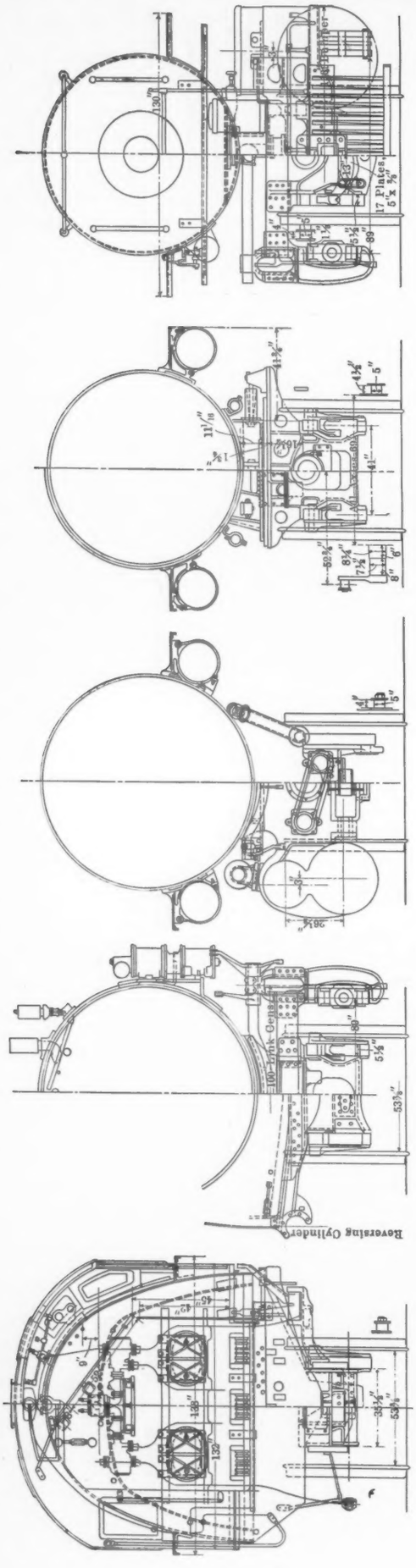
From the standpoint of the shop, the original Vauclain four-cylinder compound principle as applied to a 2-8-0 type locomotive was "no good" for the following reasons: in that construction, on account of the low frame it became necessary to cast the cylinders with the low pressure on top on account of insufficient clearance between it and the track if on the bottom. This in turn necessitated the valve chamber being on the bottom, on the same horizontal plane with the high pressure cylinder, a position which put the center of its head immediately behind the engine truck wheel.

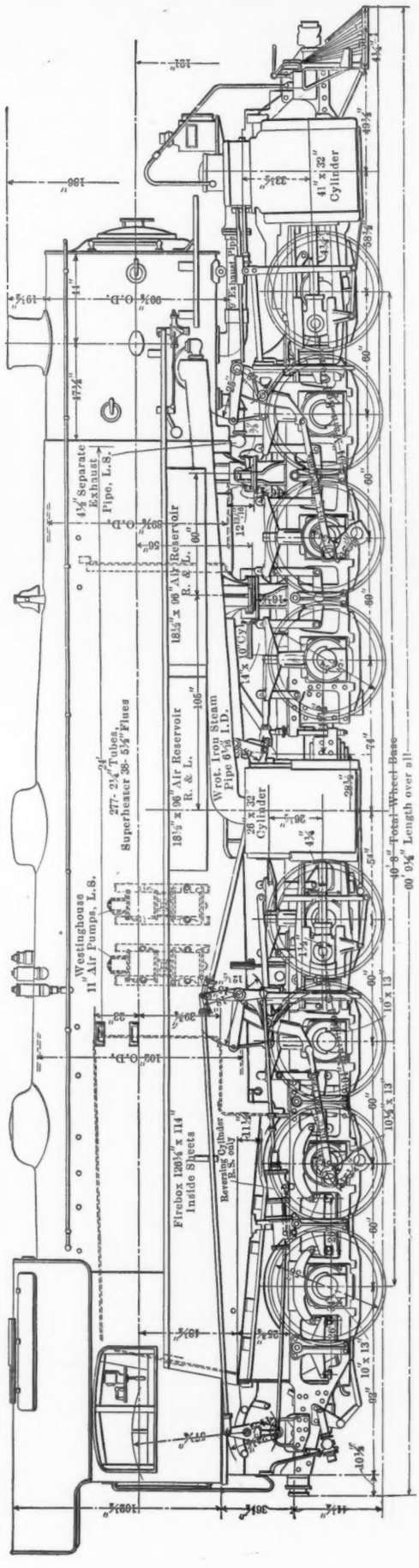
These engines were quite destructive to valve packing rings, and were practically worthless on the side which had any rings broken. The valve was very easy to pull out and the rings could be renewed in less than an hour, but unfortunately it would come only half way out of the chamber before bringing up against the engine truck wheel. Thus, what would apparently on the start prestige a respectable job became at once endowed with fearful complications; i. e., the pilot must be taken off, engine jacked up, engine truck equalizer disconnected and truck rolled from under.

It would be expecting too much from human nature for a man to repeatedly take kindly to this farce, so if it must be written, many an engine left the shop with only the front rings of the valve renewed. The percentage was probably twenty front renewals to one entire renewal. Under the eye of the master mechanic, of course, the whole laborious process as outlined was resorted to, but the real damage through neglected renewals was done at night when the force was limited and the supervision reduced to one foreman, who often willingly condoned the half done job in preference to tying up one of his gangs on a single engine all night.

This is the real menace in inaccessibility of common repair parts. There is always a great pressure of work in a roundhouse, and if the parts are very hard to get to and, unless the foreman and his men are absolutely conscientious, the temptation is almost irresistible to let the job go until the "next time," which, needless to add, never comes.

In this consideration we do not deny that extreme cases have been cited as illustrations. Some of them possibly could not be avoided, but there are hundreds of mean, petty propositions along the same lines which a little more care in location and design would effectually have eradicated. There is no need to provide obstacles tending to make unpleasant work even harder than it must be, and it is poor judgment to place the incentive in a man's way to slight it. It is confidently believed that a more intelligent handling of this very important detail will work wonders in increased locomotive efficiency, because, if the work can be reached, in nine shops out of ten it will be done, while now in many cases the peculiar construction is such that they couldn't do it if they wanted to.




41" x 32" Cylinder
4½" Separate Exhaust Pipe, L.S.
18½" x 96" Air Reservoir R. & L.
277- 2¼" Tubes, Superheater 38- 5⅝" Flues
Wrot. Iron Steam Pipe 6⅛" I.D.
28" x 32" Cylinder
11" Westinghouse Air Pumps, L.S.
Firebox 120¾" x 114" Inside Sheets
Reversing Cylinder R.S. only
10'-6" Total Wheel Base
60' 9¼" Length over all

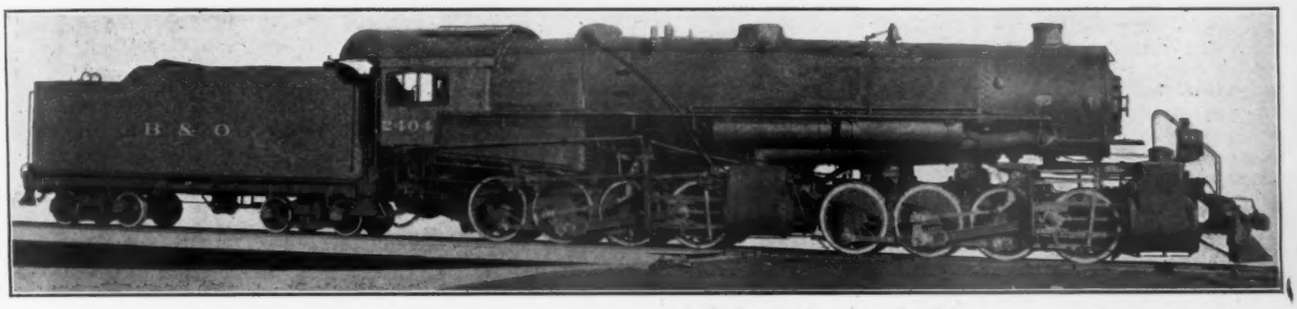
MALLET LOCOMOTIVE DESIGNED ON THE BASIS OF SEVEN YEARS EXPERIENCE WITH THIS TYPE ON THE BALTIMORE AND OHIO RAILROAD.

Mallet Locomotive With Superheater 0-8-8-0 Type

BALTIMORE & OHIO RAILROAD.

AMONG THE LATEST PRODUCT OF THE AMERICAN LOCOMOTIVE COMPANY ARE TEN MALLET COMPOUND LOCOMOTIVES FOR THE BALTIMORE & OHIO RAILROAD, WHICH HAVE A TOTAL WEIGHT ON DRIVERS OF 461,000 LBS. AND A TRACTIVE EFFORT OF 105,000 LBS. THESE ENGINES ARE EQUIPPED WITH SCHMIDT SUPERHEATERS.

At the St. Louis World's Fair in 1904 there was a locomotive forming part of the magnificent exhibit of the Baltimore & Ohio Railroad which, next to the locomotive testing plant, was the center of attraction for motive power men from all over the world. This ponderous machine was viewed with amazement by foreign visitors and with critical interest by American railroad men. "Monstrosity" was the term often applied to it; other exclamations were "an absurdity," "freak," "never will stay on the track," "cannot keep the steam pipes tight," etc. That locomotive weighed 334,500 lbs. and was the first Mallet type to be built in this country. At that time it had not been in service, having just been delivered to the Baltimore & Ohio Railroad by the American Locomotive Co., and every one could express his opinion of it untrammeled by facts.



NEW LOCOMOTIVE ON THE B. & O. R. R. FITTED WITH SCHMIDT SUPERHEATER.

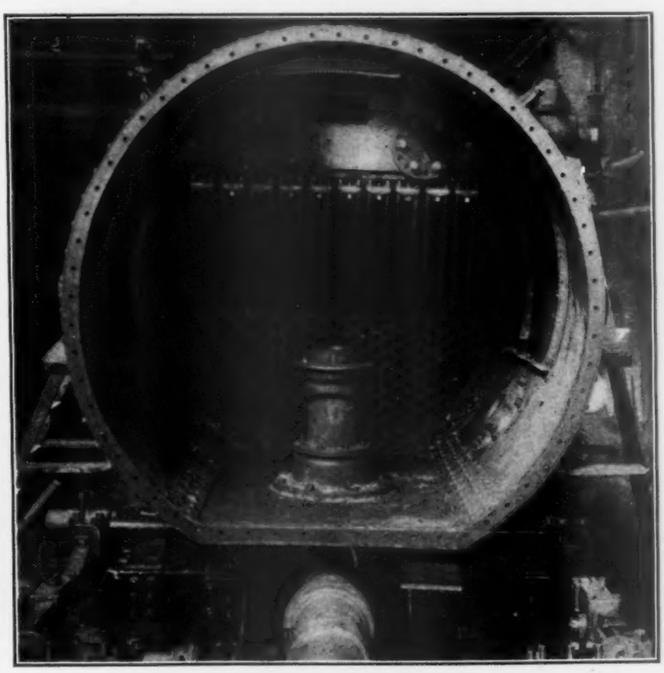
That practically every one was wrong in their snap judgment probably is best illustrated by the fact that now, but seven years later, the same company is receiving from the same builders ten locomotives of the same type, which are nearly 50 per cent. more powerful and 35 per cent. larger on the basis of weight. There is now no doubt in the mind of anyone but what these engines will be a success.

A comparison of these two locomotive designs, seven years apart, is an excellent illustration of the progress in locomotive building in this country during that time. Reference to the table on the next page will show what has occurred. Taking everything into consideration there is an increase of about 40 per cent. in the seven years.

Experience with Mallet compound locomotives almost from the beginning indicated that trouble could be expected from wet steam in the low pressure cylinders, and it is now becoming quite general practice, on the largest examples at least, to apply superheaters, which not only correct this trouble, but also give a decided economy in the high pressure cylinders. On the Santa Fe it has become the custom to apply a low degree superheater ahead of the high pressure cylinders and then reheat the steam in another superheater before passing it to the low pressure. In the present instance, however, a Schmidt high degree superheater is employed, furnishing sufficient superheat before the steam enters the high pressure cylinders to prevent any condensation in the low pressure. In this case the superheater is of the single loop system and contains 1,000 sq. ft. of heating surface in 152 1⅜ in. tubes.

It will be noticed that after seven years experience with a Mallet locomotive without front or rear trucks that the Baltimore & Ohio Railroad has decided in favor of this construction and the present locomotives are of the 0-8-8-0 type.

With the exception of the locomotives of the 2-10-10-2 type on the Santa Fe, illustrated elsewhere in this issue, these engines have the greatest weight on drivers of any on our records. The weight per axle is 57,625 lbs. and is carried on 10 x 13 in. journals, the main journal being 10½ in. in diameter. This gives an average pressure of about 219 lbs. per sq. in. on the brasses.



VIEW IN FRONT END SHOWING SUPERHEATER. THE STEAM PIPES ARE NOT IN PLACE.

The boilers on these locomotives, which are very similar to the design applied for the Dalaware & Hudson Company,* are the largest ever constructed wherein the whole is evaporating heating surface. They measure 90 in. in diameter at the front ring and 102 in. at the connection. The tubes are 24 ft. in length and a combustion chamber 38 in. long has been incorporated. The use of the high degree superheater requires the carrying of the steam forward in a dry pipe in the customary manner

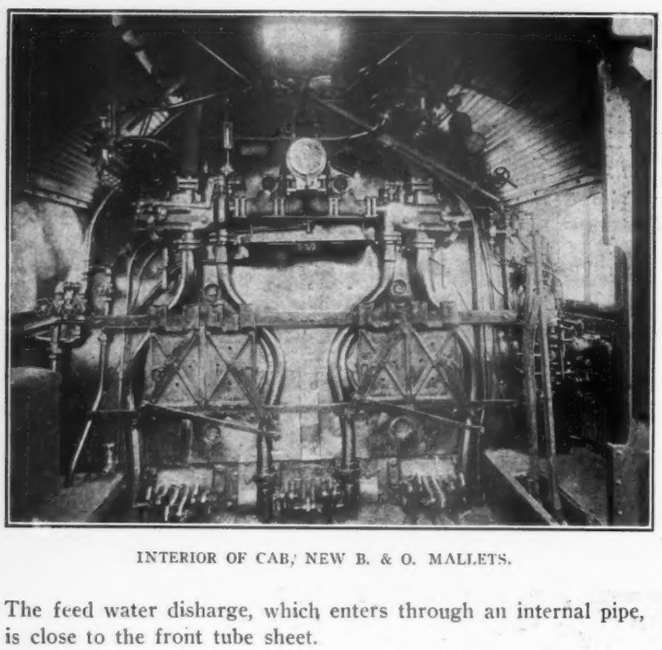
* See AMERICAN ENGINEER, June, 1910, page 207.

for a simple engine and outside steam pipes extending from the front end to the high pressure cylinder. This same arrangement was followed on the Delaware & Hudson engine, although no superheater was there employed, because of it being inadvisable to use outside steam pipes from the dome on so large a boiler. The pipes in this case are 6 in. inside diameter wrought iron pipes and are arranged with a slip joint at the elbow connecting into the high pressure steam chest. They are, of course, very heavily lagged and carefully supported to the boiler shell. A surge plate, with enlarged openings for the tubes to pass through, is located about 54 in. back of the front tube sheet.

	1904	1911	Increase Per Cent.
Type	0-6-6-0	0-8-8-0	....
Total weight (on drivers)	334,500	461,000	38
Tractive effort	70,000	105,000	50
Cylinders, diameter	20 & 32	26 & 41	30
Cylinders, stroke	32	32	....
Steam pressure	235	210	11*
Diameter drivers	56	56	....
Tubes, number and diameter	436—2¼	277—2¼	36½*
Tubes, length	20 ft. 10 in.	24 ft.	20
Tubes, heating surface	5,380	5205.5	3¼*
Total heating surface	5,600	5,526.9	1⅓*
Equivalent heating surface	5,600	7,029.9	25
Grate area	72.2	99.9	38.3
Wheel base, driving	30 ft. 8 in.	40 ft. 8 .ni	33
Wheel base, engine and tender	64 ft. 7 in.	77 ft. 2¼ in.	19
Tender, water capacity	7,000	9,500	35
Tender, coal capacity	16	16	....

* Decrease.

TABLE SHOWING PROGRESS IN LOCOMOTIVE DESIGN ON THE B. & O. R. R.



INTERIOR OF CAB, NEW B. & O. MALLETS.

The feed water disharge, which enters through an internal pipe, is close to the front tube sheet.

These locomotives are in many ways similar to the ones on the Delaware & Hudson mentioned above. The tractive effort is the same in both cases, although the Baltimore & Ohio engine has 4 in. greater stroke, which is off-set by the drivers being 5 in. larger in diameter and the steam pressure 10 lbs. less.

One of these engines has been fitted experimentally with a Crawford stoker having three troughs.

The drawings and photographs show the details of construction and the general dimensions, weights, ratios, etc., are given in the following table:

GENERAL DATA.

Gauge	4 ft. 8½ in.
Service	Freight
Fuel	Bit. Coal
Tractive effort	105,000 lbs.
Weight in working order	461,000 lbs.
Weight on drivers	461,000 lbs.
Weight of engine and tender in working order	642,500 lbs.
Wheel base, driving	40 ft. 8 in.
Wheel base, total	40 ft. 8 in.
Wheel base, engine and tender	77 ft. 2¼ in.

RATIOS.

Weight on drivers ÷ tractive effort	4.4
Total weight ÷ tractive effort	4.4
Tractive effort x diam. drivers ÷ equivalent heating surface*	837.00
Total heating surface ÷ grate area	55.00
Firebox heating surface ÷ total heating surface, per cent	5.80
Weight on drivers ÷ total heating surface	83.20
Volume equivalent simple cylinders, cu. ft	29.7
Equivalent heating surface* ÷ vol. equiv. cylinders	237.00
Grate area ÷ vol. equiv. cylinders	3.36

CYLINDERS.

Kind	Mellin Compound
Diameter	26 and 41 in.
Stroke	32 in.

VALVES.

Kind, H. P	Piston
Kind, L. P	D. P. Slide
Greatest travel	6 in.
Outside lap	1 in.
Inside clearance, H. P	5/16 in.
Inside clearance, L. P	⅜ in.
Lead	3/16 in.

WHEELS.

Driving, diameter over tires	56 in.
Driving, thickness of tires	3 in.
Driving journals, main, diameter and length	10½ x 13 in.
Driving Journals, others, diameter and length	10 x 13 in.

BOILER.

Style	Conical
Working pressure	210 lbs.
Outside diameter of first ring	90 in.
Firebox, length and width	126 3/16 x 114 in.
Firebox plates, thickness	⅜ & ½ in.
Firebox, water space	F-5", B-4", S-4½ in.
Tubes, number and outside diameter	277—2¼ in.
Tubes, length	24 ft.
Superheater fire tubes, No. and diameter	38—5½ in.
Superheater steam tubes, No. and diameter	152—1⅜ in.
Heating surface, tubes	5,205.5 sq. ft.
Heating surface, firebox	321.4 sq. ft.
Heating surface, total	5,526.9 sq. ft.
Superheater heating surface	1,002 sq. ft.
Grate area	99.9 sq. ft.
Smokestack, diameter	20 in.
Smokestack, height above rail	15 ft. 6 in.

TENDER.

Tank	Waterbottom
Frame	10 and 15 in. channels
Wheels, diameter	33 in.
Journals, diameter and length	6 x 11 in.
Water capacity	9,500 gals.
Coal capacity	16 tons

* Equivalent heating surface equals total heating surface plus 1.5 times superheater heating surface.

A TRAVELING STOREHOUSE

The stores department of the Atchison, Topeka and Santa Fe Ry. at Topeka, Kansas, has recently inaugurated the traveling storehouse method for handling supplies. It if proves to be the success expected, it will be extended to points on the system other than the coast lines where it is now being tried out.

A new supply car, recently completed in the shop at Topeka, is to be started from a given point on the first day of every month. Shelves, pigeonholes and other receptacles are arranged in such a manner as to greatly facilitate the handling of small materials and stationery. For conveying larger and heavier material additional flat cars attached to the main supply car are used. On receipt of requisitions for repairs and renewals the storekeeper will assemble and load on the cars sufficient material for the main line covering track tools, frogs, switches, cattleguards, farm gates, fence wire, staples, spikes, bolts—in fact, all items for renewals aside from complete bridges or buildings. After loading has been completed the flat cars containing the heavier material will be coupled in ahead of the main supply car in a regular train. It will probably require six or eight cars to transport satisfactorily all the material required for a single trip.

At present it is the intention to cover the Albuquerque, Arizona and Los Angeles divisions only, and, if it is found possible to cover the entire coast lines once a month, arrangements for an extension of this new method will be made accordingly. The operation and development of this new way of collecting, transporting and delivering supplies will be watched with interest all along the line. On a previous trial with a temporary car on five divisions of the system it was found that a saving of over three thousand dollars a month was made on the various items carried at that time, and it is expected that, through the co-operation of other departments, when the details of the present trial are worked out, an even greater saving in time and money will have been accomplished.

ELECTRIFICATION IN BOSTON

Two years ago a very elaborate report was made by a commission which suggested a complete rearrangement of all railroad terminals in the city of Boston and involved the construction of a tunnel which rendered electric operation necessary. This report was referred to a joint commission, which last year submitted a preliminary report to the legislature, recommending that it request the railroads to make investigations and studies with reference to electrification. The legislature, however, amended the report by requiring the commission to present with its report a draft of a bill which should compel the electrification of all steam railroads in the metropolitan district within a stated time. The railroads made a report to the joint board last November and the commission had but two months in which to study the subject and present its report to the legislature. In this report, made last January, it advised against any compulsory legislation, but the opinion was not unanimous except in that particular.

At the March meeting of the New York Railroad Club, being the seventh annual electrical night, Professor George F. Swain, department of engineering, Harvard University, who was a member of this commission and a signer of the majority report, presented in a very clear manner the line of reasoning which led to the conclusions as reported by the majority. Mr. Swain spoke in part as follows:

The so-called metropolitan district comprises a number of cities and towns in the neighborhood, and is bounded simply by the boundaries of those towns and cities. It, therefore, comprises an irregular area around the State House in Boston extending from ten to fifteen miles and in a few instances perhaps twenty miles out. The average distance is only ten or fifteen miles from the center. There are three main systems of railroad entering Boston: The N. Y., N. H. & H. System enters from the south and southwest; the Boston & Albany from the west; and the Boston & Maine from the north and west. There are some twenty-one different branch lines of these three systems comprised within the so-called metropolitan district; and a compliance with the compulsory legislation suggested by the last legislature would have required the electrification of these twenty-one the whole or parts of various lines, some of which form loops, extending as I said from ten to fifteen miles from the center of the city.

Now, you will observe that that is an entirely different problem from that which exists in New York City. Here you have the New Haven and New York Central roads running almost north from the terminal station, with only three branches, whereas in Boston we have some twenty-one branches to consider.

Now, the reports from the railroad companies indicated the cost and the various elements which entered into the problem around Boston. We are all of us agreed, undoubtedly, that we would like electrification. The Boston public is no different from the New York public, or the Chicago public or the public of any other large city in that respect. The advantages are undeniable. The reduction of smoke; the increased distance which can be covered in a given time, owing to the quick acceleration of electric trains; and the increasing value of property in the vicinity of the roads owing to the noiseless operation, and the absence of smoke and dirt, are three great advantages to the public. There are also, of course, advantages to the railroad companies, and unquestionably economies can be effected. The saving of coal by electric operation is undeniable; the saving of repairs is undeniable; the saving in corrosion of overhead structures, due to escaping smoke and gases from locomotives is also undeniable. Then there are economies which may in some cases be effected by utilizing the space over tracks for building. Whereas no use can be made of the space over the tracks of a steam railroad, it is possible to utilize the space over electric stations for office buildings, or for buildings of many sorts, in large cities. But that, however, is a real estate problem. In some cases it may prove to be a source of economy, while in other cases it would not be, because no such investment of capital would be justified. Then the economies in the saving of switching by the use of multiple unit trains is undeniable. So that in electrification everybody admits that there are great advantages for the public, and for the railroad companies as well.

On the other hand, electrification is very expensive. The question is whether it is wise to attempt to secure by legislative compulsion a thing which we all want to have, independent of the question whether it can be secured with ultimate resultant economy to the public. As I said, the board in Boston concluded that it was not wise to recommend any compulsory legislation.

Now, I think that most people are fair-minded and if they have the facts clearly presented to them, that they will not be consciously unfair in arriving at their conclusions. But I think most of us, and indeed all of us, are apt to make mistakes in reasoning from facts, or to base our conclusions upon insufficient facts. I think among the public in general there is a great deal of misapprehension with reference to electrification. And I think we have too many people who believe, because they want a thing, that this is sufficient ground for demanding it, especially if they can make somebody else give it to them for nothing.

Now, as I have said, the conditions in Boston are very different from those in New York. There are some twenty-one lines radiating from the center, extending out fifteen or twenty miles to the limit of the metropolitan district. The reports from the railroad companies indicated that the cost of electrifying the principal lines in the metropolitan district would be $40,000,000, for the passenger traffic alone—of course, for freight traffic there would be a considerable addition to that expense, and unless electrification were applied to both the freight and passenger traffic its advantages to the public would be materially reduced. $40,000,000 is a very large sum of money for the State to require the railroads to expend. Furthermore, the expenditure of this large sum would only electrify these various lines for an average distance of twelve or fifteen miles out.

Now, in New York City with the expenditure of half that sum, or about $22,000,000, the N. Y. Central and New Haven Companies have electrified their lines twice as far, or for a distance of thirty or more miles out, embracing a large part of their suburban traffic.

It is very expensive to electrify the stub ends of a number of lines. I think that is where an unjust comparison is often made. Boston people come to New York and seeing what is done here, they say if the New York railroads are able to give that service, they don't see why the Boston lines ought not to be compelled to give it. Of course, the electrification of an entire railroad presents a very different problem from electrifying only twelve or fifteen miles on one end of a steam road. In the latter case not much saving is effected on the steam operation, while the cost of electric operation is added. The steam locomotives have to be disconnected ten or fifteen miles out, and the trains are hauled from that point in by electric locomotives. The expense of steam operation is not materially reduced, while the expense of electric operation within the electric zone is added. If an entire railroad or an entire locomotive division could be electrified resultant economies could perhaps be secured. This is a very different thing from electrifying the stub end of a road.

The metropolitan district includes among the 21 lines I have mentioned some which join main lines just within the limits of the metropolitan district, which were left out in the estimates There did not seem to be any reason why the consideration of a problem of this kind should be limited by arbitrary town boundaries. The limit of electrification should depend mainly on traffic considerations, not on town lines. Hence the lines proposed to be electrified by the expenditure of $40,000,000 did not include all those 21 branches, but only some 14 or 15 of them.

Now, the first fact brought out by the reports of the companies was this great cost of $40,000,000 for the electrification of only a part of the lines within the district, and for passenger traffic alone. That would not, of course, remove the smoke nuisance, which would perhaps arise more from the freight than from the passenger traffic. The second fact developed was the statement from the roads that so far as experience showed on the New York end of their lines, the introduction of electricity did not effect any resultant economy. That is, the cost of electric operation was greater than the cost of steam operation, independent of the interest on the capital. Now, of course, nobody can reason about this theoretically and arrive at any reliable result. I do not suppose that even an electrical engineer would venture to do it; and still less should a lawyer or a civil engineer or a layman. It is the result of the experience of roads which have electrified the ends of their lines that the cost of operation is greater than it was before. The companies tell us—both of them—that to electrify the lines entering Boston would not be economical independent of the interest on the large expenditure involved. Notwithstanding this, I presume a good many people think the railroads ought to be obliged to go to such an expense, because it is for the convenience of the public.

The third consideration which the Board had in mind and which it considered was very important to take account of, was the broad economical question as to the effect of this electrification on rates. Of course, if the introduction of electric traction were to increase enormously the traffic, it might prove economical in the end. The Long Island Railroad of New York is a very different problem from the one presented in

Boston. The Long Island Road is not a freight handling road. It is a passenger suburban road, mainly; while the lines entering Boston are freight lines. The great freight lines from the northwest and the southwest which take all the freight to and from the metropolitan district of Boston are the ones to be electrified. You see, these are very different lines from those of the Long Island Railroad, which is a suburban passenger distributing road. This Long Island suburban passenger traffic was not specially studied by us, because we thought that was a very different proposition from that presented by the New York Central and New Haven lines.

If the State requires the railroad companies to expend a vast amount of money for an improvement of this kind it ought to guarantee a return on the investment. It cannot fairly expect a public service corporation, it seemed to us, to expend so large a sum unless it could see its way to doing it voluntarily; because the State could not practically guarantee a return on that investment. Of course, in order to get the return on this investment of $40,000,000, the proper place to put it would be on the suburban rates, because the suburban passenger traffic would be the traffic to reap the benefit of the proposed electrification. But to raise the suburban rates from Boston would be a hazardous thing to do, because of the very short distance, comparatively, that the electrification would extend, and the fact that the entire area is honeycombed with trolley street surface lines. You probably know that a great deal of money has been spent in Boston in building subways. These subways are being extended every year, and just now there is a proposition to expend between $5,000,000 and $10,000,000 in addition to that already authorized for the purpose of facilitating the bringing of the suburban traffic by the surface trolley lines to the shopping district or the center of the city for a single fare. On the Newton circuit line of the Boston & Albany, a loop line, which goes to about ten miles from the city, the passenger traffic has not materially increased, we are told, in the last ten years. The district has grown up, but while the traffic on the street car lines has increased, that of the steam railroad line has not increased.

Thus it is clear that if the passenger fares should be raised, not only would the people be dissatisfied, but a still larger traffic would tend to be diverted to the street car lines, and the steam railroads might not get the additional revenue they require to cover their additional expenditure. Should this be the result, they would have to gain the needed revenue from the long distance passenger traffic or the freight traffic. Of course, we all know that the railroads cannot get back from each class of traffic the cost of that particular traffic. The reason is that the cost of the different items of traffic cannot be determined. It is impossible to determine what it costs to haul a ton of any given commodity from one point to another—there are so many elements which enter into this cost. Fairly, however, if costs could be exactly ascertained, each class of traffic should pay its own cost. From this point of view, the cost of electrifying the lines in the metropolitan district should be charged in some form on the Boston business. Boston is talking a great deal to-day about its port. As a matter of fact, I believe Boston has a better port than New York, and indeed the best port on the Atlantic coast. It has deep water and a clear channel right out to sea, only a short distance. But of course, it is a railroad terminal and it is handicapped to some extent by the fact that freight from the West in going to Boston, instead of sliding down hill from Albany along the Hudson river, has to be hauled up over the Berkshire Hills, and in hauling it up over the hills, the trains have to be split in two, because a locomotive cannot haul more than half the load it could on the West Shore or N. Y. Central. Therefore, the expense is greater in getting western freight to Boston, than in getting it to New York. Now, anything which would have a tendency to add to that expense or to detract from Boston's advantages as a port should not be considered for a moment. I am giving you the opinion of the majority of the Board, of which I was a member. Anything which would increase the rates on freight traffic to Boston would certainly be detrimental to the growth of Boston as a port.

Then there was a still larger and broader point of view which suggested itself to us, and that had to do with the general problem of the regulation of the railroads. Personally I believe in proper government regulation of steam railroads and other public service corporations. We all know that the establishment of the Interstate Commerce Commission has resulted in abolishing evils which the railroads themselves are glad to have abolished and which many of them had tried to have abolished before that commission was created, but without success.

However much we may desire electrical operation, it certainly must be considered as yet, so far as the public is concerned, a luxury. It is a luxury which we would all like to have. The question is, can we afford to pay for it?—because the public has to pay for it in the end, no matter how it is supplied, whether voluntarily or by compulsion. Now, it did not seem to us that this was something that the government should compel the railroads to furnish. We thought it was going a little too far to require a luxury.

Furthermore, a still greater and larger point of view which suggested itself was the moral effect of the passage of compulsory legislation. If one state should begin to require electrification, probably other states would follow. New York and Boston are not alone in desiring to get rid of the smoke nuisance and have electrification. All the great cities in the country want the same thing. Now, it can easily be realized what the result would be if all the states, or many of them, should compel electrification of their steam railroads. The result would be the requiring of enormous sums of money, and in raising these sums capital would not be assured of a return. It might in some cases obtain a return after a time, and in some instances traffic might be quickly increased so as to insure a fair interest on the additional invesement; but it would not be insured from the beginning, and in some cases it would not be *insured* at all.

Now, as we all know, our railroads are required every year to expend large sums of money for many things, in order to keep pace with the growth of the country. They must expend these sums to provide new tracks, new yards, new roundhouses, new equipment and all the various things which go to make up a modern railroad. The business doubles every few years. We all know what happened in 1906-7 when many of the railroads were not prepared for the large increase in traffic. Capital has to be assured of attractive investment, and if the states require compulsory electrification, capital may be deterred from investing in railroads even for the expenditures which are necessary, because of the fear of additional and onerous legislative requirements.

Another thing which seemed to us to make unwise the enforcement by legislative enactment of this much desired improvement was the fact that electrical engineers are not yet agreed as to a standard of electrification. The N. Y., N. H. & Hartford and the Boston & Albany proposed to install in Boston the same systems they use in New York City—two different systems such as there are here. This would require, therefore, if the trains of one road are ever to run over the tracks of another the duplication of machinery and unnecessary expense. The state of the art is not yet in such a condition that compulsory measures should be taken, it seemed to us.

A fact illustrating the great changes which may be brought about in a short time in the relations of the different roads in and about Boston has been brought to our attention since our report was made; and that is that the N. Y., N. H. & H. Railroad has asked the State Legislature for permission to build a tunnel under the harbor connecting its tracks on the south with the Boston River Beach and Lynn Railroad on the north—a narrow gauge independent line—so that through trains may be run into Boston, from New York and Providence under the harbor, and out on the north over the line just mentioned and the Boston & Maine line, to Portland and the Provinces. Now, thirty years ago all these railroads were independent of each other. The Boston & Providence railroad was a line by itself. The eastern division of the Boston & Maine and many other lines which now make of that system, were independent. If anybody had prophesied at that time that he would live to see through trains running over the Boston & Providence, the Revere Beach, and the Eastern Railroad, he would probably have been considered an imbecile. Yet that is something which now seems very near and indeed within reach.

The future relations between the steam railroads are just as uncertain now as they were then. Perhaps it may not be true that such great changes will take place in the future as we have seen in the past. Still, we cannot venture to predict what the result will be. These branch lines out of Boston are so interlaced that nobody knows what the future will evolve. It, therefore, seems that we ought not to hasten electrification in advance of the standardization of electrical appliances. The ideal electrification would be such that the trains of any line could run over any other line.

Now, those are the main reasons, gentlemen, which led the board in Boston to conclude that it was best to allow the problem to work itself out. There are those who disagree with our conclusions, and we must always respect the opinions of those who differ from us, especially on questions of public economy and public welfare; for we are all seeking the public welfare—or ought to be—although we may differ as to the best means to secure that welfare.

The minority of our Board thought the majority report would tend to unduly discourage electrification, that it made the objections too strong. I think they failed to realize, perhaps, that our objections were to compulsory electrification and that we were not against electrification if the railroads should choose to indulge in it. They said our report would tend to prevent the introduction of any electrification in Boston. But since that report was made, the New Haven road has petitioned the Legislature for permission to build this tunnel under the harbor, which of course would require electric operation and that of

course would require the electrification of the road at both ends of the tunnel. I think the roads should begin in this way and after their experience had gone far enough they should extend the electrification as far as they can see their way clear, and perhaps it will be long before our lines are electrified for long enough distances to produce some real economy. We may within a short time if the railroad companies are left to themselves, and allowed to proceed in the economical way, see the New Haven lines electrified to Providence and perhaps all the way to New York. I think this would be better than requiring first the electrification of a lot of little stub ends. So, if the problem is left alone, it will take care of itself, and the revolution will be according to economic laws.

I have described to you the condition of things and the status of the question as it presented itself to us. The matter is still before the Legislature. I do not know what they will do. They may pass some compulsory legislation, but I sincerely hope that they will see that it is not in the real public interest to do so. I believe the majority of thoughtful and well informed people realize that it is not in the true interest of the public to place undue burdens upon the carriers, but that they should be allowed to work this problem out themselves.

A WELL EQUIPPED CLEARANCE CAR

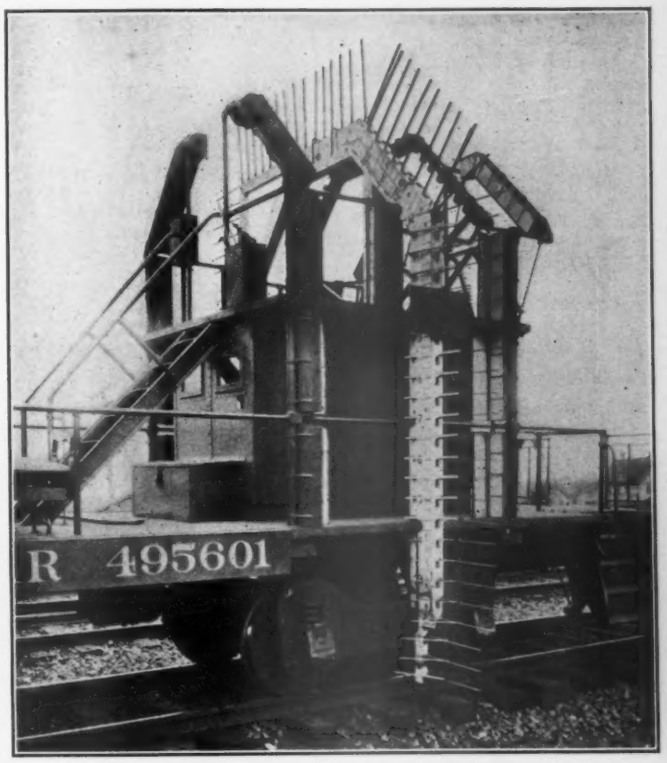
A new clearance car has just been placed in service on the Pennsylvania Railroad Lines East of Pittsburgh and Erie. This car was designed in the office of the Engineer of Maintenance of Way and built at the company's Altoona shops and is being run over every division as rapidly as possible in order to secure correct measurements of the distances from the track to projecting portions of station buildings, tunnels, bridges and other objects. It is also designed to indicate automatically while moving on curves the elevation of the rails and the degree of curvature.

The car, which is 54 feet 8¾ inches long over all, and 30 feet between truck centers, is built entirely of steel, and is equipped with air brakes, steam fittings and electric lights. The main floor is 4 feet 5¼ inches above the top of the rail and at the front end of the car where the templets are located is a second floor at an elevation of 9 feet 8 inches above the top of the rail. Both floors are for use in taking measurements from the templets. The second floor is reached by steel stairways on each side of the main templet. All measurements are taken at the center of the car truck, from which clearances are computed. The main templet, which is erected directly over the center of the truck, has a width of 10 feet between elevations at 2 feet and 12 feet above top of rail, exclusive of the fingers or feelers attached to the sides. From an elevation of 12 feet above top of rail, the templet recedes towards the middle of the car at an angle of 45 degrees, reducing the width of the templet to 4 feet at the top, at an elevation of 15 feet above top of rail.

Immediately in front of the main templet is constructed an auxiliary templet, designed to measure overhead bridges, tunnels and other objects between elevations 17 feet and 20 feet above top of rail. This auxiliary templet has the same dimensions as that part of the main templet between elevations 12 feet and 15 feet. It is supported on a center shaft enclosed in an upright cylinder and is capable of being raised to a height of 18 feet by a crank and ratchet arrangement on the floor of the car. Enclosed in steel cylindrical boxes with translucent glass fronts facing the templets is a series of electric lights which extend from the floor of the car on each side thereof to a height of 15 feet above top of rail. The well diffused light thus obtained makes it possible to take measurements both day and night, as well as in dark tunnels.

The fingers or feelers attached to the sides and the top of the templets are two feet long and are spaced six inches apart. They are hinged to the templets and held in the different positions by friction. Attached to the feelers and the side of the templet are graduated scales which indicate automatically the distance from the rim of the templet to a side or overhead object. In addition, a small board equipped with a set of feelers spaced one inch apart has been provided to measure cornices of roofs of shelter sheds, or other irregular objects close to the track. This board is detachable and can be fastened to the side of the templet at any point desired. As the car passes over a curve, an attachment on the rear truck indicates the degree of curvature on a scale inside of a cabinet which has been erected in the middle of the car. In this cabinet is also an instrument consisting of a long pendulum suspended vertically which indicates automatically the elevation of one rail of the track over the other. The side of this cabinet facing the main templet has been provided with a plate glass window, which enables the operator of the car to read the degree of curvature, or the elevation of the rail at any time.

With all of the attachments working automatically, it is possible to take clearance measurements while the car is running



CLEARANCE CAR OF THE PENNSYLVANIA R. R.

at a speed of four miles per hour; this is necessary at times in order to keep out of the way of regular trains. Though two men can operate the new clearance car, one taking the readings of the scales and the other recording them, where clearances are close and irregular it requires the services of three men.

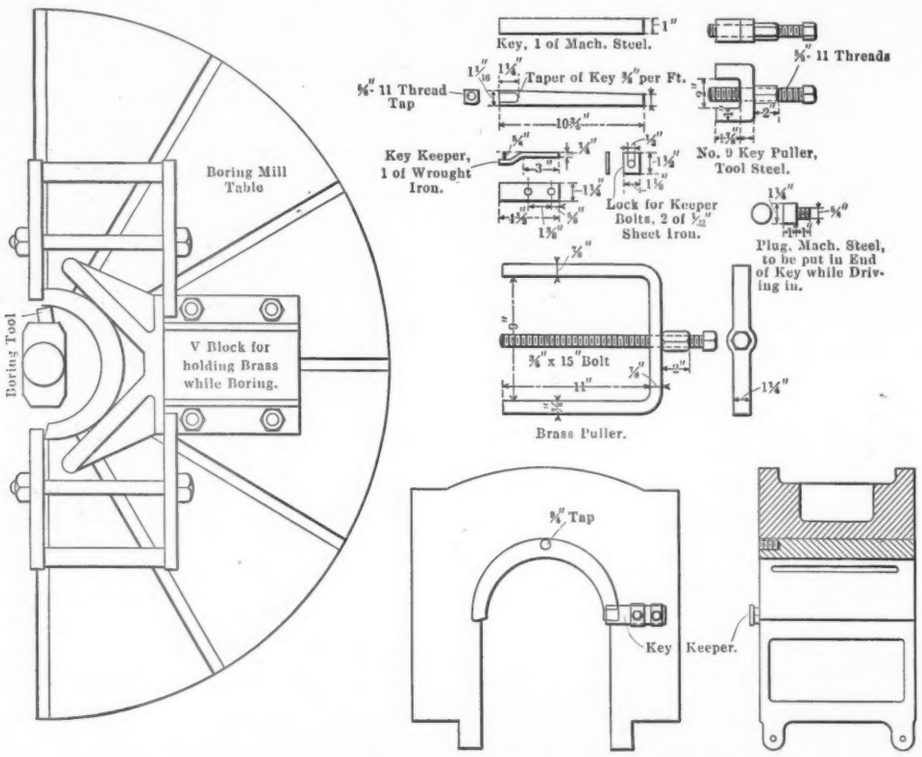
THE CASE FOR THE MASSACHUSETTS INSTITUTE OF TECHNOLOGY in its appeal to the commonwealth for additional aid may be briefly and simply stated. It receives from every student a tuition fee of $250 a year; it expends $470 a year upon the education of each student. The school receives from the State of Massachusetts at the present time $25,000 a year toward the maintenance. It is the recipient also of interest upon certain endowment funds. But it would still show an annual deficit were it not for voluntary contributions from its alumni and friends. An agreed sum annually from the former has helped the school to tide over financial stringency in the last few years. This agreement is about to expire by limitation. Over and above all this, the school is confronted with the necessity of moving into larger and better quarters. Eight hundred students from Massachusetts alone are enrolled. Figured at the per capita loss mentioned above, the net cost of these students to the school is $176,000 per annum. The president and corporation of the institute feel that it is not asking too much of the commonwealth to contribute less than two-thirds of this amount yearly in consideration of the benefits accruing to its citizenship.

REMOVING DRIVING BOX BRASSED WITHOUT DROPPING THE WHEELS

CHICAGO & NORTHWESTERN RY.

A very successful method of removing worn driving box shells without resorting to the usual drop pit operation as a preliminary has been developed in the Clinton shop of the Chicago and Northwestern Railway, and is being extended to other points on that system. Through the use of the appliances illustrated the entire process, including the renewal of the brass, can be performed in from four to five hours, and at a cost for labor of not more than four dollars.

The cellar is first removed from the box having the brass to be removed and blocking placed between the pinder and each leg of the box. The engine is then jacked until the brass is about one inch off the journal. If the former is loose in the box a ¾ in. hole is drilled and tapped in the end and it is removed by the brass puller, shown in detail in the accompanying drawing. Should the brass be worn so thin in the crown that this plan is not permissible it is divided by a ripping tool and the two halves removed by hand.


Boring Mill Table
Boring Tool
V Block for holding Brass while Boring.
Key, 1 of Mach. Steel.
Taper of Key ⅜" per Ft.
⅝" 11 Thread Tap
⅝" 11 Threads
Key Keeper, 1 of Wrought Iron.
No. 9 Key Puller, Tool Steel.
Lock for Keeper Bolts, 2 of ½" Sheet Iron.
Plug, Mach. Steel, to be put in End of Key while Driving in.
¾" x 15" Bolt
Brass Puller.
¾" Tap
Key
Keeper.

DETAILS OF JIG FOR REMOVING DRIVING BOX BRASSES.

The new brass is turned 1/64 in. less than the box fit and its left hand lug planed to fit that of the driving box. On the right hand side, instead of a fit on the lug, allowance is made for a long tapered key of machine steel. This key is flat on the bottom, but the top is planed ⅜ in. taper to the foot to correspond with that on the lug of the new brass. The key is made first and placed in the box, the ends being allowed to project 1½ in. A tin or sheet iron template is then fashioned to fit the opening in the box, and this form is transferred to the end of the brass for the planer hand to work to. If the work is properly done the key will drive 1⅜ in., which will produce 30 to 35 tons pressure on the brass fit. To bore the brass for journal fit, it is held central and parallel on the boring mill table by the jig as shown. The drawing is fully explanatory of the remaining details of the general operation.

THE INTERNATIONAL RAILWAY GENERAL FOREMEN'S ASSOCIATION will hold its next convention in Chicago, July 25-27, 1911, instead of in May.

A PRACTICAL RUST PROOFING PROCESS

The prevention of rust in metals has not by any means been the least of the problems which the engineering profession in the past has been called upon to solve, but heretofore the efforts toward that end has been discouraging in view of the generally unsatisfactory nature of the results which have been attained. It was not until a quite recent date, when the "Bontempi" process was given publicity by the Eastern Rust Proofing Co., of Long Island City, New York, that it became apparent a solution is now at hand, and that it is possible to cheaply treat any metal in a manner to render it impervious to this destructive agent.

The Bon-tempi rust proofing process was brought out about four years ago. In this process the articles to be treated are placed in a muffle, and heated sufficiently so that the pores in the metal are opened. A patented compound of chemicals is then injected into the muffle, creating fumes which fill the pores and fix a magnetic oxide on the metal. The time required for treatment depends upon the character and chemical constituents of the articles treated, ranging from a half hour to an hour and a half, this latter time for steels high in carbon. With the ordinary treatment the surface is not materially added to, but through the process it is possible to reach a depth or thickness of one-sixteenth inch or even more if desired.

When removed from the muffle the specimens treated are of a silver gray color when cooling. An oil bath gives a dead black surface which under the buffing wheel can be made to take a finish like polished gun metal. Articles thus treated will take paint and nickel-plating. A particularly appealing feature in connection with the process in general is that complicated devices can be treated without being dismembered. The penetrating power of the treatment is such that in a layer of small articles one foot deep, or even more, all of the articles receive exactly the same treatment. The size or amount of iron to be treated at one time depends entirely upon the size of the muffle.

Among the exhibits of the company, illustrating the durability of the process, are locks, all interior working parts of which have been rust-proofed in position, and screws and threads on pipes, treated in place, show no filling of the threads, the screws turning after treatment as easily as when first cut. A valve

which had withstood a pressure of 300 lbs. to the square inch was rust-proofed in all its interior parts, without being taken apart, showing that the fumes will go wherever air or gas can penetrate. Numerous other samples are on exhibition, the larger portion of which were treated over two years ago, and some of these have been constantly in the open, subject to the action of the elements and salt sea air, without the slightest sign of oxidization.

NEW CONCAVE BLADE COLD METAL SAW

In response to the widespread demand for an efficient cold metal saw, thoroughly dependable under all conditions, and of sufficient capacity to meet general shop requirements, the Newton Machine Tool Co., of Philadelphia, Pa., has developed an entirely new design of remarkable possibilities, which embodies several features of merit which will particularly appeal to all users of this now generally recognized indispensable tool.

This new concave blade cold metal sawing machine, shown in the accompanying illustration, is a departure in the design of sawing machines, in that the teeth of the blade are on the inside, thus reversing their arrangement in machines of the ordinary type. The many advantages obtained through this construction are obvious, and in this instance they are the result of long and careful study on the part of the designers with the end in view to secure the principle in a practical form, and one which would be exempt from criticism. The saw illustrated has eight internal teeth and will clear 7 in., although rated only as a 5 in. machine. Other sizes are for 12 in. and 15 in. diameters, particularly adapting the machine to locomotive axles and automobile work, in cutting of gear blanks from bar stock.

The machine consists of a very heavy cylindrical barrel, about 28 in. diameter in its bearings, on the periphery of which is located a bronze worm ring having teeth of steep lead, 37¼ in. outside diameter. The driving worm is of hardened steel fitted with roller thrust bearings, and the opposed stresses due to the drive are absorbed by the saddle in which the driving hub and worm wheel have a common bearing. The saddle is of exceptionally heavy construction, made with the base and cap securely bolted together, and having ample provision for oiling. It is fitted with square lock gibbed bearings on the base with adjusting screws to compensate for wear. The feed is obtained by a gear box giving nine changes of feed, and there is also available reversing fast power traverse. The feed screw is of very large diameter and has a bearing at each end to permit of its being maintained in alignment. The machine is driven by a General Electric, 20 h.p. motor.

Although not the first machine embodying the internal cutting principle, it is the first on the market of the simpler design having positive direct gear drive. The photograph herewith illustrating an end section of one of a number of cuts made and giving the time of the operation, portrays the steady, even motion of the blade when working under these severe conditions. Greater feeds could undoubtedly be obtained, but are not recommended by the builders for commercial practice.

SPECIMEN CUT SHOWING STEADY MOTION OF THE SAW BLADE.

NEW DESIGN COLD SAW WITH INTERNAL TEETH.

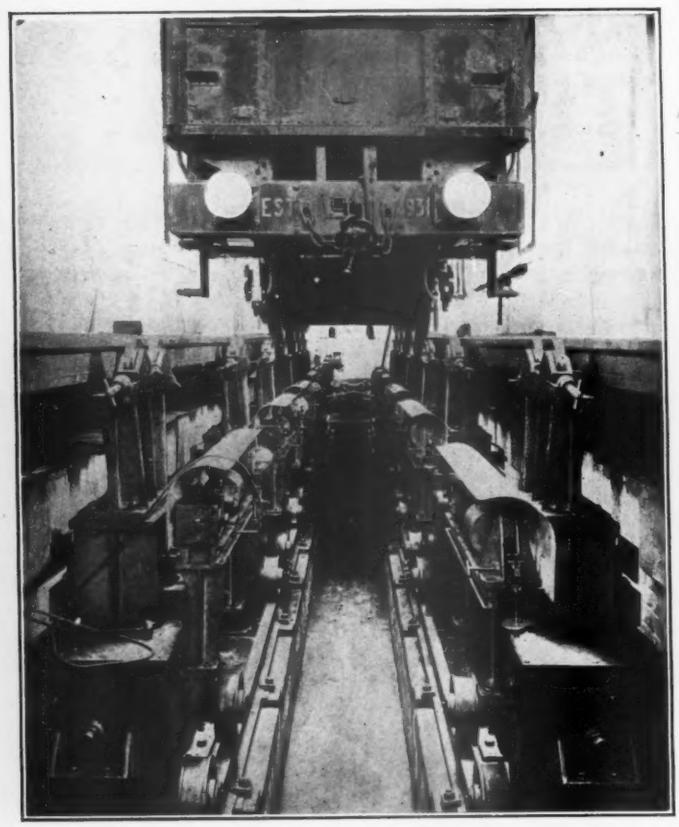
This machine occupies little floor space and appears to be an ideal type for supplanting lathes and other makeshifts which may still be found around many shops engaged in cutting up shafting, bar stock, gear blanks, etc., work which properly belongs to the metal saw and which can be handled thereon at a minimum of expense as compared with the primitive methods referred to.

A GERMAN PATENT HAS BEEN SECURED for the manufacture from the Soya bean of a product to take the place of rubber. The process, says an American consular report, consists in the reduction of the oil of the Soya bean to a thick, tough liquid through the addition of nitric acid. After further treatment with alkaloid solutions the mixture is heated to 150°, giving a tough, highly elastic product similar to rubber, which can be vulcanized by the same process as rubber.

THE SCHENCK LOCOMOTIVE SCALE

The question of properly estimating the adhesive weight of locomotives is one to which increasing attention is being paid by locomotive builders in Europe. It is, of course, recognized that the stability of locomotives depends in great measure upon a good distribution of the weight on the axles, and the exigencies in this regard are becoming greater as progress goes on, owing to the continual increase in the speed. Thus it is of the greatest importance that the distribution of the weight on each of the wheels should be carried out as closely as possible On the other hand, it is evident that upon the exact distribution of the load depends the proper running and length of service of the locomotives.

So far as Europe is concerned, up to the present the adhesive weight has been determined either by calculation or by actual



NEW TYPE OF LOCOMOTIVE SCALE.

weighing by the use of what is known as the Ehrardt balance. However, owing to the various drawbacks which are said to be incurred with this latter system, inventors have been at work upon different apparatus which would replace it. An interesting weighing system which is not by any means an experiment, but is constructed by one of the best known German firms, the Carl Schenck Works at Darmstadt, is herein illustrated. It is now used not only in that country, but in quite a number of railroad shops all over Europe, particularly in France and Russia. Owing to the very careful design, which is the result of long experience in this field, it very justly claims to represent the most recent progress in locomotive weighing.

As will be noticed in the photograph, the installation comprises a certain number of movable weighing apparatus, all alike, and mounted on carriages, so as to lie along the pit in two ranges. Each of the apparatus is designed so that the upper part can be raised under the locomotive wheel and bear up against the rim so as to lift the wheel off the track, thus raising the locomotive as a whole by means of each wheel. The mechanism which actuates the lifters is all operated by a common shaft passing along the side of each range. The two shafts are connected at the ends by gear and chain drive so as to be both worked together, and all the lifting is thus done from the end of the pit and at the same time. Thus the locomotive is raised quite equally and without oscillations. The movement can be carried out by hand through a ratchet lever, or by motor drive, preferably an electric motor. As to the scales proper, they are enclosed in a stout cast iron box mounted on four rollers so as to form a carriage, and running on rails laid along the floor of the pit. The scales work on the common steelyard or balance principle, so that they are of simple construction and easily standardized. Owing to the very limited space which was available for lodging the different parts of the lever mechanism, quite a special design had to be used for the levers.

The lifter, which receives the weight of the locomotive and brings the load in turn upon the levers, is made of suitable iron castings, and on the top is the wheel support, this being a cast iron base carying a pair of tempered steel rollers. The roller holders can be adjusted back and forth by screws, so as to adopt the rollers to take the rim of the locomotive wheel in the proper way. Ball bearings are used for the roller shafts, so that these can be readily turned even while taking a load of 12 tons per scale. All the divided scale beams lying on the outside and carrying their sliding weights are placed conveniently in line within the pit, and are easily handled for the weighing. The reading is done as usual by sliding the cylindrical weight along the scale beam.

In order to obtain exact results in the weighing it is quite necessary that the upper rails carrying the locomotive, as well as the lower rails supporting the carriages, should be horizontal whether the balances are loaded or not. This condition has been carefully attended to in the design, and the rails bearing the carriages are laid upon the foundations of the pit in the proper way, while the upper rails are fixed upon a series of channel bars placed parallel and solidly connected to the foundations.

Weighing with the above apparatus is carried out easily and simply. The locomotive is brought over the pit, in which are installed at least as many scales as there are wheels. The scales are then placed well under each wheel, and the rollers adjusted against the rims by using the screws. By working the device as a whole from the end of the pit, all the lifters are brought up at the same time in the position of load. Where an electric motor is used, it is specially easy to stop the rising movement automatically at just the right height for the weighing. Here the locomotive is quite lifted off the rails and is held entirely upon the set of apparatus. It only remains to balance the scale beams by the sliding weights and then the load upon each wheel is read off at once.

One point to be noticed is that while the locomotive is resting upon the scales, the wheels can be turned about upon the roller supports without any trouble. New readings can be thus taken in order to see what differences of weight may come from changing the position of masses in movement such as counterweights, pistons, cranks, etc. That the Schenck system is meeting with considerable favor is borne out by the fact that it is approved by leading railroad men in all the countries of Europe and in less than five years more than 50 installations are in service. In Germany about 25 installations are in operation on the different railroads. France counts 5 plants upon the government and other railroad lines, and others are now in construction.

RAILWAY DEVELOPMENT IN WESTERN CANADA.—The year 1911 bids fair to establish a new record in railway development in western Canada. Recent announcements made by Sir Thomas Shaughnessy, of the Canadian Pacific, and Sir William MacKenzie, of the Canadian Northern, show that these two roads will spend fourteen and twelve millions, respectively, and will add at least a thousand miles of new trackage to the railway facilities of the West this year.

THE REGULAR ANNUAL MEETING of the American Railway Industrial Association will be held at Hotel Cadillac, Detroit, Michigan, May 9th and 10th, 1911. Opening session 10 A. M.

ELECTRIFICATION OF CHICAGO TERMINALS

Preliminaries looking to the final electrification of Chicago terminals are said to include immense freight switching yards south of Grand Crossing to be used by all roads entering the city from the south and southwest, another on the northwest side for Northwestern and St. Paul and about thirty small yards along the Belt Railway at each intersection, making almost a continuous border of freight yards around the city. Chief Engineer A. S. Baldwin, of Illinois Central, says:

"The railroads in considering such a plan are not exactly discounting the time when they will be forced to electrify; they are not admitting that they expect to lose their fight against immediate and universal electrification in the city. This plan of outer yards is one that would be equally advantageous if the terminals were not electrified, but more necessary in the latter case.

"The new system would allow the switching to be done in the outlying districts where the old steam locomotives could be used. When sorted and made up into trains the freight could be sent to the team tracks and freight houses on the various yards by electric motors, doing away with a large part of the down-town switching.

Chicago will go into the scheme blindly as no similar situation has ever confronted operating heads of our railroads. New York has put electric motors in its terminals, but there was never any great freight movement in the district now electrified."

Chief Engineer Trumbull, of the Great Western, says: "The plan of having outer distributing yards is almost universally conceded to be the only solution of the freight problem in case the roads are forced to adopt electricity as motive power in the heart of the city. The objections of the switchmen are being overcome in the new plans."

EXTRA HEAVY FOUR-SIDE CAR SILL PLANER

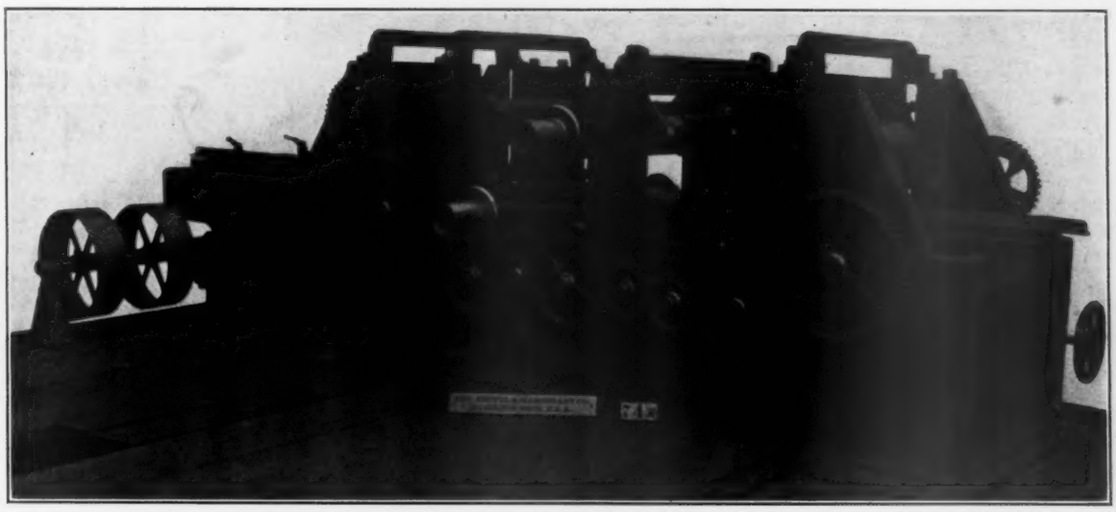
This exceptionally powerful four-side car sill planer is a recently re-designed output of the Bentel & Margedant Co., of Hamilton, O., and not only represents the most modern, but one of the largest and best constructed of its kind on the market. The weight of the machine is about 10,000 pounds, and it is furnished with two countershafts, one at each end. It is adapted for matching, timber dressing and a very wide range of heavy work, planing two sides 24 in. by 12 in. or four sides 20 in. by 12 in.

The unusual strength secured in the design is apparent in the illustration. All parts are of extra substantial and stiff construction, particularly adapting it for the exacting character of the work for which it was built. It is well adapted for the heavy duty of planing all of the material used in freight car work, and finishing it in one operation. It may also be fitted with matcher heads for tonguing and grooving material.

The lower head is placed in front so as to operate on the material first. This feature is one which will no doubt commend itself at once to the users of these tools. It affords a smooth surface for the material to slide upon, and a place to gauge and measure from; makes a division of the cut between the two heads, and allows the parts of the machine to be brought close together. The head is carried in a heavy housing which is made to slide entirely out of the machine for ease and facility in sharpening the knives.

The upper head comes next to the lower. It is mounted rigidly in a massive housing, raising and lowering through two heavy screws. The heavy bonnet chip breaker carries an adjustable shoe on the bottom which can be set close to the knives, and it swings entirely out of the way for sharpening and adjusting the latter.

The side heads are carried in housings of entirely new construction, and each side head has a swinging chip breaker, swinging out of the way so that the head may be easily got at for adjustment. The side head housings are each moved by two screws, each pair being geared together and operated from the working side of the machine. The lower end of the mandrel runs in a step box which allows the end to rest in oil, thus insuring that it will positively run without heating.



REDESIGNED CAR SILL PLANER FOR WIDE RANGE OF HEAVY WORK.

The feed rolls, six in number, are of large diameter, with heavy journals, and powerfully driven by a train of large expansion gears. They raise and lower in massive housings by means of screws and a system of levers. All rolls are raised and lowered by power simultaneously, the operator standing at the feeding end and simply throwing in a lever. The feed has three changes of speed, varying from 30 ft. to 65 ft. per minute. It can be given faster or slower speed by changing the size of the pulleys. The whole length of the machine, including countershaft, is 17 ft., and the maximum width 5 ft. 4 in.

THE LARGEST STORAGE BATTERY PLANT.—A storage battery plant, said to be the largest single-battery plant of its kind in the world, will be erected by the Consolidated Gas, Electric Light and Power Company, of Baltimore, as soon as a building now being constructed for it is finished. The building will adjoin the largest direct-current sub-station of the company, and will cost about $50,000, while the entire cost of the plant will approximate $300,000. The storage battery will be of sufficient size to provide for the peak load in the entire business district for nearly half an hour should an accident occur at the time of maximum consumption.

TESTS OF FREIGHT CAR TRUCKS

For the purpose of finding out the facts with reference to the running qualities of freight car trucks that are held reasonably square as compared with those constructed in such a way as to be free to get out of square, Professor Endsley of Purdue University on invitation of the American Steel Foundries conducted a series of tests during the past year at Granite City, Ill.

A special piece of track was constructed for the purpose of these experiments, consisting of a sharp incline having a drop of about 36 ft., which was followed by a short tangent of 30 ft., then a 22 deg. curve 303.3 ft. in length, the outer rail being raised 4½ in., followed by a tangent of 257 ft. and ending in an incline having a vertical rise of 20 ft. The gauge was 4 ft. 8½ in. on the tangents and 4 ft. 9 in. on the curve. The curve had a rise of 3 ft. 10¾ in. in this length, and the tangent following it had a total rise of 11.73 in. From the foot of the starting incline there was also a straight piece of level track 600 ft. in length at the end of which there was an incline of about 25 ft. rise.

The tests were conducted upon the different types of freight car trucks and different modifications of the same type of truck, which had been taken from under cars in regular service. There were 24 trucks tested. The brake shoes and brake beams were removed to eliminate any friction that might result from the contact of the shoe with the wheel.

In beginning a test the truck was carefully weighed, was then pulled up the incline to the desired height, being released a number of times until the distance it would run before stopping became constant. When testing on the curved track five record runs were made and when testing on a straight level track the runs were continued from four to six hours by alternately running the truck loose for two runs and square for two runs. The velocity at any point was determined by means of an electric chronograph.

In obtaining the resistance in pounds per ton the following formulæ was used:

$$K = \frac{V^2 W}{2g} + \frac{\left(V\frac{G}{R}\right)^2 W_1}{2g}$$

$$L = K_1 - K_2$$

$$F = \frac{L}{D}$$

$$P = \frac{F}{T}$$

Where
P = Force in pounds per ton.
V = Velocity of truck in feet per second.
W = Total weight of truck.
W_1 = Weight of wheels and axles.
T = Weight of truck in tons.
R = Radius of wheel in feet.
K = Total kinetic energy.
K_1 = Kinetic energy at any point of track.
K = Kinetic energy at another point of track.
L = Loss of kinetic energy.
D = Length of track in feet for which the loss in kinetic energy was obtained.
F = Average force in pounds acting on the truck.
G = Radius of gyration in feet of a pair of wheels and axles about the center line of the axle. It was necessary to know this radius of gyration in order to determine the kinetic energy in the truck due to the rotation of the wheels and axles. This was done experimentally by swinging a pair of wheels and axles as a pendulum and using the formulas,

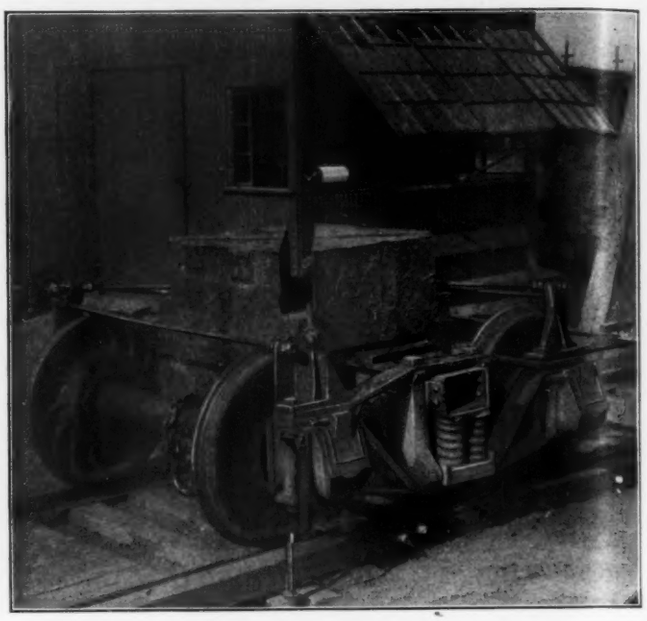
$$t = \pi\sqrt{\frac{G_1^2}{g\,s}}$$

$$G^2 = G_1^2 - s^2 = \sqrt{\frac{t^2 g\, s}{\pi^2}} - s^2$$

In which
t = Time of a single oscillation.
s = Distance in feet from center line of axle to the knife edge supports.
G_1 = Radius of gyration about the point of support.

The radius of gyration as obtained for a pair of 700 lb. 33-in. cast-iron wheels and their axle was .573 ft., and for a pair of 33-in. Davis cast-steel wheels and axle was .559 ft.

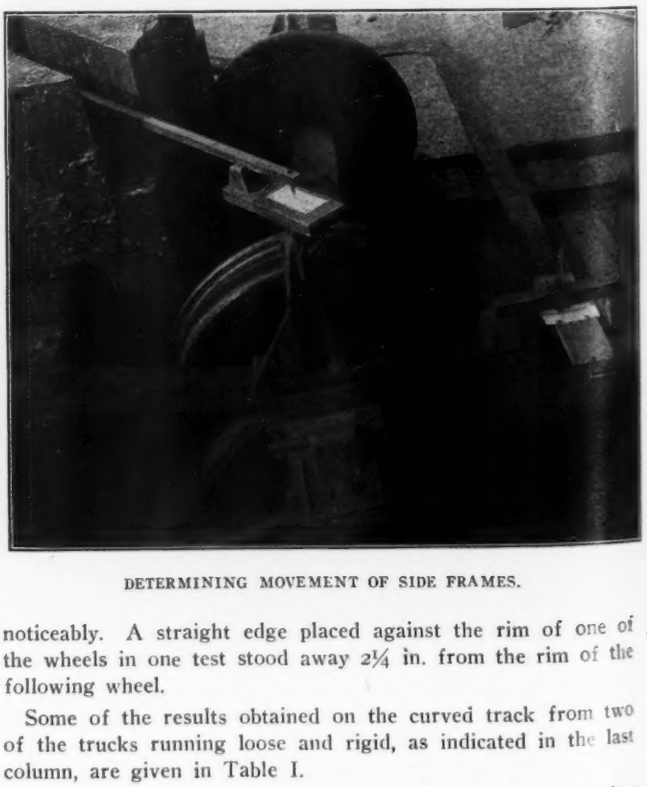
For recording the movement of the side frames relative to each other two methods were used, one consisting of measuring the increase and decrease in length of the diagonal from the top of one journal box to the other, which was done by having a wooden arm carrying a pencil at one end pivoted to the corner casting on the truck and reaching diagonally across to the other corner. This pencil recorded its movement on a card attached to the truck frame. The second attachment consisted of two bars of iron fastened on top of the journal boxes, one of which had a 90 deg. bend and reached across the track, and carried a suitable board on which was fastened the card. The other bar constituted a support for the free end of the



METHOD OF HOLDING ARCH BAR TRUCKS SQUARE.

first bar and was equipped with a suitable arrangement for holding a pencil. This would record the exact motion of one side frame with respect to the other.

During the tests it was found that a loose truck would go out of square on a curve so that the flanges of one wheel would be out of line with the flanges of the wheel in front of it very



DETERMINING MOVEMENT OF SIDE FRAMES.

noticeably. A straight edge placed against the rim of one of the wheels in one test stood away 2¼ in. from the rim of the following wheel.

Some of the results obtained on the curved track from two of the trucks running loose and rigid, as indicated in the last column, are given in Table I.

Truck A was an experimental arch bar truck, conforming closely to standard practice in its design and construction. It had a specially constructed cast-steel bolster which, being con-

TABLE I.

Test No.	Truck	Wheels Front	Average Speed in Feet Per Second		Average Speed in Miles Per Hour		Kinetic Energy in Foot-Pounds		Loss in Kinetic Energy on Curve Ft.-Lbs.	Total Force on Truck on Curve Pounds	Resistance on Curve Lbs.-Ton	Resistance on Curve Corrected to Level Track Lbs.-Ton	Total Movement of Side Frame Inches
			At Beginning of Curve	At End of Curve	At Beginning of Curve	At End of Curve	At Beginning of Curve	At End of Curve					
I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	XIII	XIV
1	A	1 and 2	33.84	26.80	23.07	18.27	246,442	154,556	91,886	302.95	48.39	22.69	None
2	A	1 and 2	34.33	24.92	23.40	16.99	251,268	132,384	118,884	391.93	63.21	37.51	3.78
3	A	1 and 2	27.83	15.66	18.97	10.68	165,115	52,280	112,835	372.00	60.00	34.30	3.78
4	A	1 and 2	27.87	18.55	19.00	12.64	167,137	74,039	93,098	306.95	49.03	23.33	None
5	A	1 and 2	24.69	13.74	16.83	9 37	131,533	40,613	90,920	297.69	47.65	21.85	None
6	A	1 and 2	24.53	9.32	16.73	6.34	128,280	18,516	109,762	361.69	58.36	32.66	3.78
7	A	1 and 2	22.98	11.01	15.67	7.50	113,532	26,087	87,475	288.31	46.05	20.35	None
8	A	1 and 2	22 98	4.17	15.67	2.84	112,476	3,701	108,775	358.63	57.84	32.14	3.76
9	B	1 and 2	23.80	11.84	16.25	8.08	213,254	52,773	160,481	529.11	46.25	20.85	None
10	B	1 and 2	23.66	5.30	16.15	3.62	210,786	10,572	200,214	660.11	57.70	32.00	3.78
11	B	1 and 2	25.51	10.80	17.42	7.37	245,001	43,906	201,093	663.01	57.95	32.25	3.78
12	B	1 and 2	25.31	14.74	17.25	10.05	241,183	81,796	158,388	525.51	45.95	20.23	None
13	B	1 and 2	28.44	19.39	19.39	13.22	312,656	141,654	171,002	563.80	49.28	23.58	None
14	B	1 and 2	28.24	16.46	19.25	11.22	300,257	102,004	198,253	653.65	57.13	31.43	3.78
15	B	1 and 2	34.90	27.51	23.79	18.75	458,594	284,993	173,661	572.57	50.49	24.79	None

siderably heavier than commonly used, made the weight of the truck 12,520 lbs. No spring plank was used. The truck had 650 lbs. cast-iron wheels. The wheel base was 5 ft. 4 in. Although the wheels were cast several years ago, they were not worn, never having been in service except on the experimental track. The treads and flanges were in good condition. The wheels taped slightly larger than the standard 33-in. wheel. Truck B was the same as A, with the exception that a casting weighing 10,366 lbs. was added, thus making its total weight 22,886 lbs.

In the table the first ten columns are self-explanatory. Column XI was obtained by dividing the values in Column X by 303.3 ft., this being the length of the curve. Column XII was obtained by dividing the values in Column XI by the weight of the truck in tons, and Column XIII was obtained by subtracting from the values in Column XII 25.7 lbs., the force necessary to overcome the resistance due to the rise in grade.

In order to show more clearly the relation between the resistance in pounds per ton on a curve and the amount that the truck gets out of square, the results of all tests on the curve track were plotted. The values were obtained by dividing the values in Column XIV of Table I, by 2, the assumption being made that the amount that the truck went out of square is equal to one-half of the recorded movement of the side frames with respect to each other. During a number of tests an observer rode the truck and observed the movement of the recording pencil, which seemed to indicate that the amount that the truck went out of square was practically the same for both the outward and the inward trips around the curve. The results were plotted in the order in which the trucks went out of square, and it is apparent that the friction in pounds per ton on the curve decreased in the same order. To more clearly show this, all of the results of tests have been separated into five groups. These groups were selected according to the amount that the trucks went out of square. The average resistance in pounds per ton for each group were plotted and are shown in the accompanying illustration. It is evident that the amount that the truck went out of square had very little effect on the resistance in pounds per ton, until the truck was at least 1 in. out of square. The results obtained when the truck was out of square between 1 and 1½ in. showed the increase in resistance to be 10.06 lbs. over the resistance offered when the trucks were out of square less than ½ in.; so that there seems to be somewhere near 1 in. a point, such that if the truck gets out of square beyond it, the resistance in pounds per ton is materially increased. In order to distinguish between a square and loose truck, in view of the foregoing, it was assumed that all trucks tested that went out of square ½ in. or less would be classed as square trucks, and all of those that went out of square more than 1½ in. would be classed as loose trucks.

All of the values of the tests obtained for trucks that went out of square less than ½ in. were averaged and a resistance of 24.68 lbs. per ton obtained. Also the result for all tests of loose trucks were averaged and a resistance of 38.33 lbs. per ton was obtained. These two average resistances for square and loose trucks have been plotted, together with the average resistance on the short tangent, which resistance amounted to 6.38 lbs. per ton. With the tangent resistance as an origin, a straight line was drawn between the tangent resistance and the two curved resistances as shown, the upper line representing results for loose trucks or those getting out of square 1½ in.

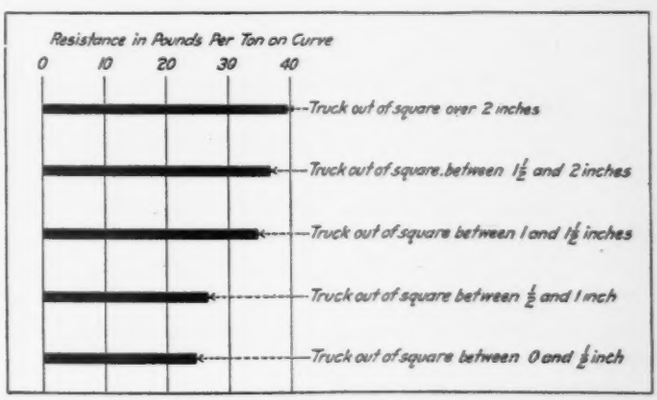
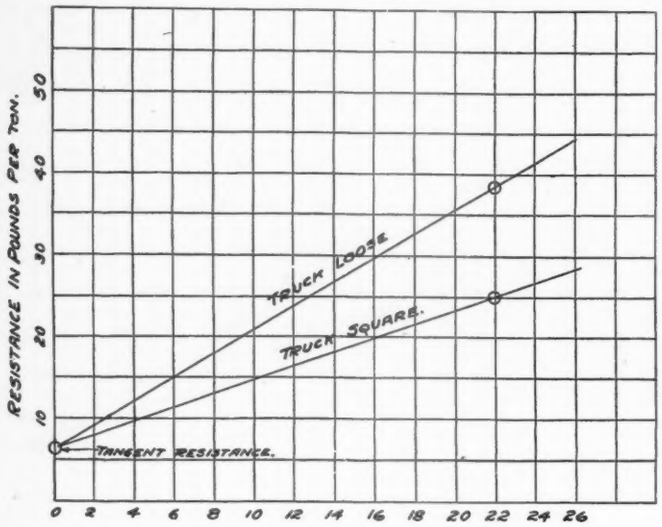

Resistance in Pounds Per Ton on Curve
0
10
20
30
40
Truck out of square over 2 inches
Truck out of square between 1½ and 2 inches
Truck out of square between 1 and 1½ inches
Truck out of square between ½ and 1 inch
Truck out of square between 0 and ½ inch

TABLE OF TRUCK RESISTANCE.

or more, and the lower line representing the square truck or those getting out of square ½ in. or less. These two lines were drawn straight because it is generally accepted that the resistance due to curves is in direct proportion to the degree of curvature. From these two lines it was computed that the per cent. of saving in favor of the truck squared varies from 7.9 per cent. on a 1 deg. curve to 36.5 per cent. on a 26 deg.



RESISTANCE FOR DEGREES OF CURVATURE.

curve, and taking 4 deg. as the average main line curve, the saving is 20.3 per cent. in favor of the truck squared.

On the 600 ft. straight track tests were also made with nonmated wheels on the same axle (Trucks A_1 and A_2). The results are given in Table II. It will be seen that the resistance under these conditions is very decidedly affected by the condition of the frame, i. e., loose or square. In Truck A_1 the wheels taped under or over the standard as follows: Wheel No. 1, 13/16 in. under; No. 2 on same axle, 3/16 in. under; No. 3, ⅛ in. over; No. 4, 5/16 in. over. On truck A_2, No. 1 and 2 wheels were the same as above, but No. 3 taped ¾ in. under, and No. 4, 3/16 in. under.

From these tests it would seem that where the wheels of the truck are not well mated, a method of construction which will hold the axle perpendicular to the track will tend to slightly reduce the resistance.

Truck	Date	Average Temp.	Initial Speed Miles per Hour	Number Runs of Truck		Average Distance Truck Traveled		Number of Feet in Favor of Square Truck	Per Cent Favor of Square Truck
				Loose	Square	Loose	Square		
I	II	III	IV	V	VI	VII	VIII	IX	X
A	10-29-'10	44°	23.07	15	12	4288	4315	27	.62
A	11- 2-'10	47°	23.62	12	12	4398	4406	8	.18
A	11- 3-'10	41°	22.41	15	13	3935	3966	31	.78
A_1	11- 5-'10	47°	24.46	20	20	3928	3957	29	.74
A_2	11- 7-'10	67°	24.22	12	11	4888	4920	32	.65
A_2	11- 9-'10	70°	23.63	6	6	5097	5254	157	3.07
					Aver.	4422	4469	47	1.06

TABLE II.

The tests so far conducted have suggested several interesting things, which could not be developed owing to the lateness of the time in the fall, so it has been decided to continue the tests next summer, at which time it is hoped that sufficient data will be obtained to clearly demonstrate several interesting as well as important matters. To this end three additional pieces of experimental track are being constructed, having a curvature of 3, 6 and 12 deg. respectively. After tests are run on these three curves, there will then be available data as obtained from four different degrees of curvature, whereby a more satisfactory comparison can be made between the resistance of square trucks and loose trucks on different degrees of curvature.

The complete report on the tests have been published in a very attractive illustrated booklet by the American Steel Foundries.

A WELL DEVELOPED TURRET LATHE

In the design of the handsome tool shown in the accompanying illustration the Indianapolis Machine Tool Co., of Indianapolis, Ind., has worked out a machine embodying many unusual features of sterling merit, and one which at the same time maintains an entire exemption from criticism. It is noticeable in the photograph that the lathe is adapted for heavy chucking and bar work, and the combination of strength and rigidity so plainly apparent insures its capability for rapid and accurate duplications. That it is heavy enough from a general standpoint to take care of the most severe strains without injury is prominent, and the convenient arrangement of the controlling and operating levers is particularly pleasing.

A study of the details of this interesting machine will afford a good indication of the progress made in the development of turret lathes, and will forcibly attest to the ingenuity of machine tool designers in so effectually eradicating the points of weakness which were so prominent in the years following the introduction of this useful appliance. In this instance it will be noted that the bed and headstock housing are one casting. The former has heavy flat ways, and in addition to a lateral rib through the center has cross ribs every 13 inches. The construction, so far as this particular feature is concerned, effectually eliminates any possibility of deflection in the bed and at the same time insures the strength which is necessary to withstand the varying stresses to which machines of the turret type are subject.

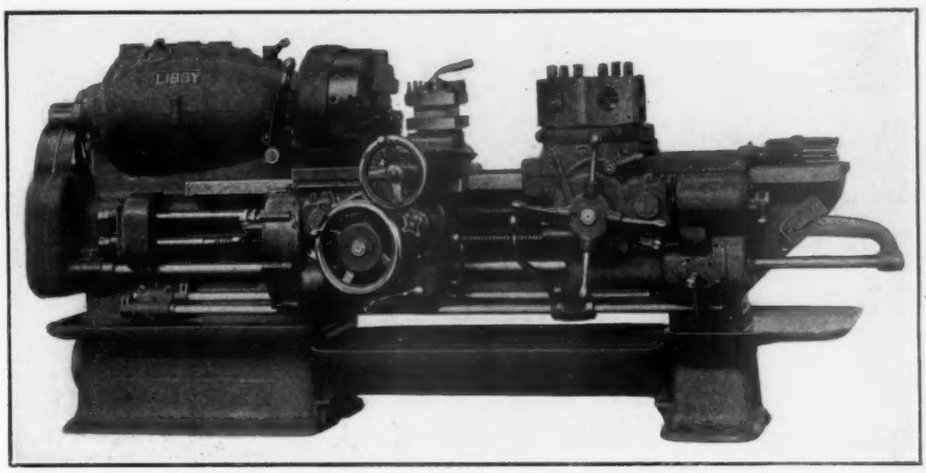
The drive is either by belt from one or two speed countershaft or by motor, either 5 or 7½ h.p. In the case of belt drive it is from a 4 in. belt to a 16 in. pulley, which drives the high speed shaft 480 r.p.m. with a one speed countershaft. If one of two speeds is desired, the high speed shaft on the second speed would be 384 r.p.m. The single belt drive mechanism is separate from the headstock proper, and is fitted into a housing cast solid with the bed and headstock, so that the whole mechanism may be removed in case of repair or adjustment. This mechanism is composed of two friction gear drives, the latter being to the intermediate shaft, giving two speeds forward, which, with the four mechanical changes in the headstock, gives eight speeds forward.

There are two double friction clutches in the headstock, one a band friction in the driving mechanism, and the other a cone friction on the intermediate shaft. Those in the driving mechanism are on a shaft which runs 480 r.p.m., and those on the intermediate shaft are on a shaft which never runs less than 240 r.p.m. In both instances the locking mechanism is such that it gives all the effect of a positive clutch without the disadvantages. The wearing parts of the friction dogs are of tool steel properly hardened, and through these frictions the operator is always in absolute control of the spindle and chuck. The main spindle is of 40 to 50 point carbon steel, with 3⅛ in. hole. Its bearings are of bronze of ample proportions, adjustable for wear, and provided with ring oilers.

The turret embodies several ingenious and novel features. It is of the hollow hexagon type, 12 in. in diameter, with six holes bushed to 3¼ in. One lever operates both the lock pin and clamp, and six automatic stops are provided, one for each face of the turret, the latter being drilled to receive the various

tools. One revolution of the pilot wheel moves the turret one inch, thus giving the operator an immense leverage in coming up against a heavy cut. A sight indicator is also provided to advise the operator of the depth of the cut should he desire to use it after the automatic stops have operated.

Power rapid traverse is provided for each carriage. This mechanism operates instantly at the rate of 40 ft. per minute, and stops immediately when thrown off. The traverse for each carriage is entirely independent of the other, and can be operated either way, regardless of what the other carriage is doing or whether the feel is on or off. In operating the power rapid traverse none of the headstock gears or feed gears are used, so that neither the pilot wheel on the turret slide nor the hand wheel on the tool post carriage turn or move in either direction when the rapid traverse is thrown in. This power rapid traverse mechanism is driven from the main driving shaft of the machine, and does not require separate countershaft or motor.



THE NEW INDIANAPOLIS TURRET LATHE.

The tool post is of the four-sided heavy turret type. It will carry four tools at one time, and each is independently adjustable for height. This tool post can be clamped in any desired position, or locked in any of eight different positions. It is of very rigid construction and has a double acting clamping device, both inside and outside, so that broad faced tools can be used to advantage. Both cross and lateral power feeds are provided, and it has a rapid traverse altogether independent which will operate either way, whether the feeds are on or off.

The tool post carriage is of the side carriage type, having a bearing on the front way 5⅞ in. by 24 in., with a long taper gib on the side of the front way. It is further gibbed to a 60 degree angle on the lower side of the bed to take care of the cross strain. In this side carriage construction the bearing, which on an ordinary engine lathe goes on the back way, is simply transferred to a bearing on the bottom of the side of the bed, thus getting the cross slide out of the way, and giving the full swing capacity to the lathe. This permits the tool post to pass the chuck and the turret to come up flush with the latter, doing away with the necessity of long overhanging tools

Minor parts of the machine have not been by any means neglected in the refinement which has been achieved in this design. Particular attention has been paid to lubrication, which is as complete as possible. The oil pans are cast iron and placed at such a height from the floor so as not to inconvenience the operator. All pans drain into the large pan in the center of the machine, which contains a strainer. From this the lubricant flows into the front leg of the lathe, which acts as a reservoir and from which the oil is pumped back to the work by means of a rotary pump, located on the back of the machine and driven from the rapid traverse shaft.

A LITTLE LARD OIL rubbed on hardened and polished steelwork, which is to be drawn on a plate over an open-forge fire, will prevent the smoke from obscuring the tempering color.

HIGH EFFICIENCY IN SAND BLASTING AND PAINT SPRAY WORK.

The advantages of the sand blast for many classes of work have been accorded general recognition for quite a long period, but the adoption of such apparatus has not proceeded hereto fore with the rapidity which might be looked for, largely on account of the excessive cost of the machinery necessary to do economical and efficient work.

The sand blast apparatus herein illustrated, which is a product of the Mott Sand Blast Mfg. Co., of Chicago, Ill., through the elimination of elaborate and useless parts, and other changes tending toward the utmost simplicity in design, effectually overcomes this latter objection, and represents the highest development which it has been possible to secure in this extremely valuable appliance. Its efficiency is just as great at the end of one or two hundred feet of hose, as at the end of a ten foot section, and it has a very great advantage in the fact that there are no devious and crooked pipes to clog. The air takes up the sand and carries it along in a straight line. The flow of sand can always be adjusted to the exact volume best adapted to the work at hand. As an illustration of the efficiency to which this machine has been raised it may be said in cleaning steel cars, one man and one machine clean an average of three cars a day, ready for the painters. This work by hand would require forty men, and the sand blast does a better job, the sand cleaning where hand tools cannot reach.

MOTT PAINT SPRAYING MACHINE.

The same principle involved in the construction and operation of the Mott sand blast has been also successfully adopted by the company in the application of paint by the spraying process. An idea of the economy in time, labor and material may be gained from tests showing that an operator may easily spread 40 gallons of oil paint of 60 gallons of mineral paint in one day, under 20 or 35 pounds pressure, with a 25-foot length of hose. The flow of the paint can be regulated to suit the work; the paint being mixed automatically. The air that reduces the paint to a spray at the same time serves the purpose of maintaining it at uniform consistency in the tank. The sand and paint machines are practically the same in constructive details.

A NEW RADIUS PLANER ATTACHMENT

In machining motion links and obtaining the proper curve in the slot several requirements are absolutely necessary in connection with the device to be employed for the work, and these may be briefly enumerated as follows:

1st.—An absolute correct circle radius.

2nd.—A rigid construction permitting of heavy cuts to keep pace with up-to-date tool capacity.

3rd.—A wide range in adjusting the rigging to any radius occurring on motion links.

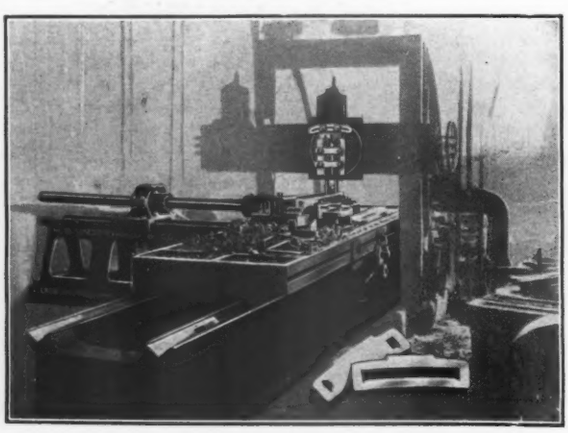
4th.—Absolute absence of wear on all parts that may impair the accuracy of the curve.

5th.—An easy adjustability to radii of any length and of changing and rechanging straight planer work with radius cutting.

6th.—A concentrated method of curve cutting in order to finish the whole operation in one setting.

A review of practically all of the various machines and methods which have been tried at different times with a view to obtaining something that would permit rapid, accurate work, and of such construction that wear would not interfere with its exactness has led to the design and construction by H. B. Underwood & Co., Philadelphia, Pa., of a new radius planing attachment which has many features of exceptional merit.

This radius attachment allows very heavy cuts and stands up to the limit of the machine tool without injury. After the link has been planed, milled around the edges, the end clearances drilled and slotted, it is set up on the chuck table and the center block removed by parting with two tools simultaneously. This parting operation, including setting up link and lifting out block after parting, has been done on a 15 h.p. planer in 35 minutes, the link of hammered steel 3½ inches deep. After parting, the slot is finished by side tools kept steadily in the other tool



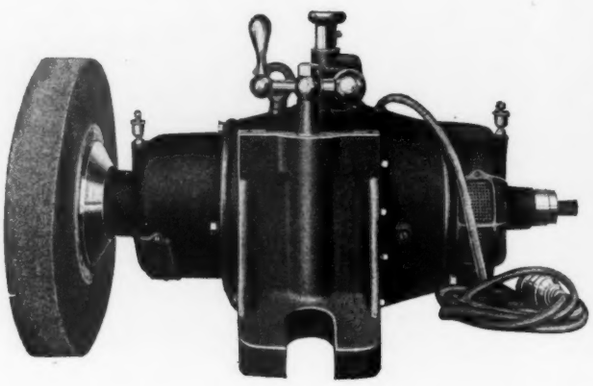
APPLICATION OF THE UNDERWOOD RADIUS ATTACHMENT.

heads of the planer. The advantage of this method consists in having one setting for blocking out and finishing both sides and in the absolute correctness of inside and outside radius.

A square block which is integral with the bottom plate, that is fixed to the planer table, transmits the driving power to the top plate always in the direction of the reciprocating movement without giving a resulting force with the tool resistance other than parallel to it. The oscillating component of the mechanism is allowed through an enlarged pin that surrounds the square block kept down by a cover plate. An enlarged eye engages around the pin and with a retaining ring forms on its top side the setting table. For setting up, the link is lined up to a center line marked on the chuck. Owing to the very small amount of stress, the radial bar is a tube, and being comparatively light, is easily handled. It permits of adjustment to radii of different lengths by means of a guide that is double pivoted in a post sliding on a foot plate perpendicular to the planer direction.

PORTABLE ELECTRIC DRIVEN GRINDER

Portable grinding machines in recent years have been accorded much favor by shop superintendents and master mechanics in view of the wide range of work in which their use is permissible, and which with the appliances formerly at hand



necessitated the removal of the part with the attendant loss of time and expense These tools have proved of exceptional value in the dressing of steel castings, which are now so generally embodied in locomotive construction, and treat with equal facility frames, wheel centers and other parts which may not require planing all over, but should still be "burred" or roughly finished.

A remarkably compact and efficient example of portable electric grinder is that herein illustrated of 3 h.p., which is a recent output of the United States Electrical Tool Co. of Cincinnati, O. It is used to considerable advantage in in railroad shops on several jobs which without its assistance would be attended by greatly increased expense. One prominent instance of this utility advanced in its favor is the preliminary treatment of skid flat driving tires before turning. In many cases of this kind the spot becomes chilled so hard that the lathe tool rides or rounds it, and it becomes necessary to turn below the spot. Proper grinding over the latter obviates this difficulty and preserves much of the life of the tire.

NEW MAIN LINE BUILT IN 1910.—Official returns from nearly all the railways in the United States show that approximately 4,122 miles of new main railway line were built in the United States during the calendar year 1910, as compared with 3,748 miles during 1909. The 1909 record was over 500 miles more than for the preceding year, which was the smallest since 1897. New main track mileage is reported in 38 States and Territories, including Alaska, where 6 miles of new track were built. Texas, which was first in 1909, was first in 1910, with 756 miles. In Canada 1,844 miles were reported, as compared with 1,488 miles in 1909, an increase of 356 miles, and in Mexico only 138 miles were reported, as compared with 281 miles the previous year, a decrease of 143 miles.

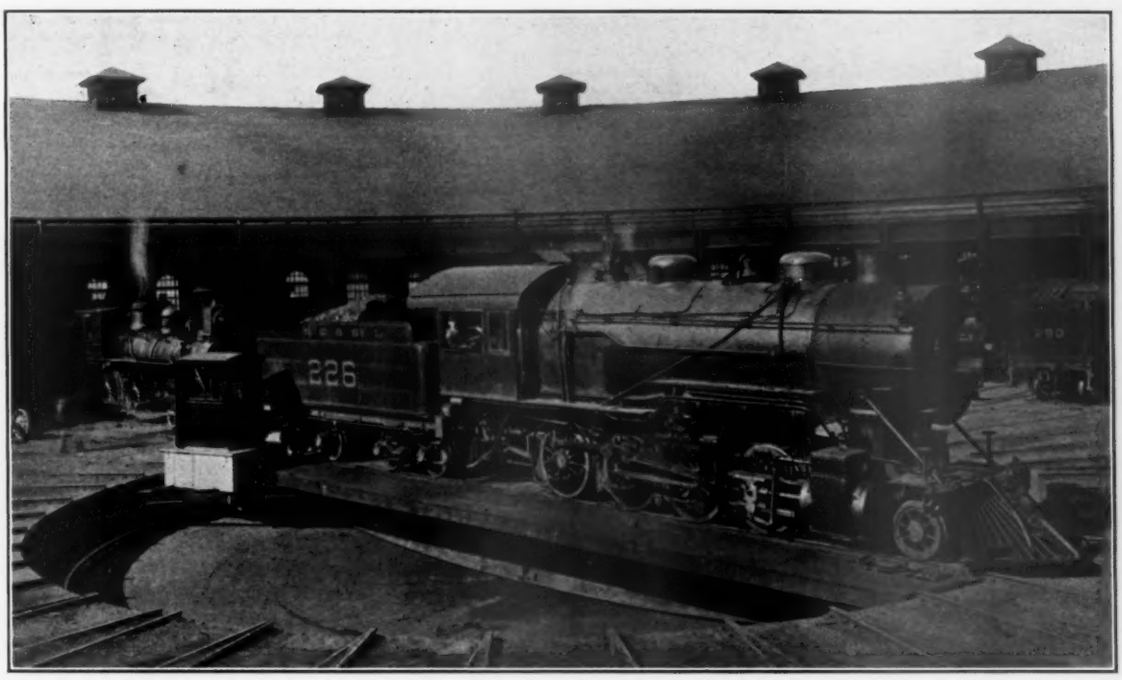
COMBINATION ELECTRIC TURNTABLE TRACTOR AND ENGINE HAUL

In many engine houses it is found necessary to handle dead locomotives over the turntable. This presents a difficult and expensive proposition, the only practical solution to which is, mounting some form of pulling device on the turntable itself. To meet this demand, Geo. P. Nichols & Bro., Old Colony Bldg., Chicago, have developed several types of engine haul, one of which is an independent device, and is usually mounted on the turntable girder near the center of the table. The control of this may be effected from the cab of an electric tractor, or from its own individual controlling stand. Occasions frequently present themselves, however, where a combined tractor and engine haul may be applied to the turntable in the same manner as a standard tractor.

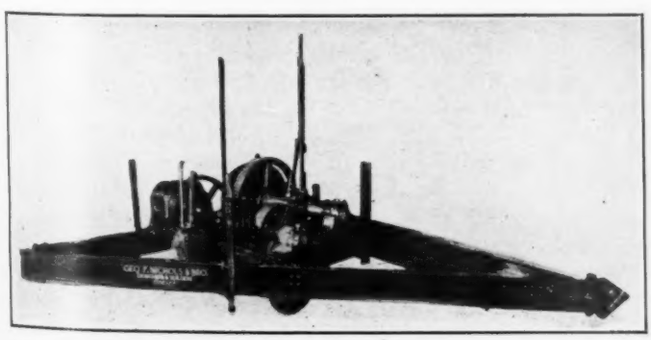
The illustration shows such a tractor attached to a 66 ft. Nashville, Chattanooga & St. Louis Ry. turntable at Nashville, Tenn. This externally presents an appearance very similar to that of a Nichols standard tractor, the only apparent difference being that the machinery space housed in is a little larger and the cab is set somewhat higher than in the standard type. Within the machinery enclosure is the usual mechanism for the turntable drive, and also the entire winding mechanism, which consists practically of a winding drum driven through a friction clutch arrangement by the same motor which operates the turntable. By the use of friction clutches mechanically interlocked with each other, the motor may be connected with the table drive or with the winding drum at the will of the operator, but it is impossible to operate both mechanisms at the same time. The winding drum mechanism and clutch arrangement are the same as are usually employed on the Nichols transfer table, and the wire rope is led off from the drum around deflecting sheaves on the turntable proper, to snatch blocks at the ends of the table, in the same manner as in transfer table practice.

A better idea may be obtained of the machinery arrangement by referring to the illustration which shows the tractor removed from the table and with the cab platform and machinery housing removed. A powerful brake is provided for the swinging mechanism, and also for checking or holding the winding drum. Above the machinery is mounted the operator's cab containing the steel switch box, the levers for the drum brake, travel brake, clutches and sand box. Current is brought to the turntable from beneath through the center casting, a swivel collector being mounted directly over the turntable center. As the turntable was an old one already in place, and the rounded top of the center casting was only 3¼ inches below the top of the rails, arranging a suitable collector presented some difficulties which, however, were very successfully overcome. As the table is very short, it is absolutely impossble to balance the newer and heavier engines which are now being turned, and the handling of locomotives prior to the installation of the tractor was exceedingly difficult and expensive. The tractor, however, is able to turn any of the engines on the table regardless of whether a proper balance is obtained or not.

Reference to the illustration shows that all of the wheels of the locomotive being turned are on one side of the center of the table, even when the locomotive is set as far back as possible. The engine haul pulls these engines on and off the table with ease. Reports show that the cost of power for turning locomotives since the tractor was installed has been less than one-quarter of a cent each.



TURNING HEAVY LOCOMOTIVE WITHOUT TURNTABLE BALANCE.



TRACTOR REMOVED FROM TABLE.

ACCORDING TO STATISTICS JUST COMPILED by the railway mail committee from reports submitted on forms prescribed by the Post Office Department by 187 railways, operating 178,710 miles on which there are 2,411 mail routes, the railways of tht United States not only receive less compensation for handling the mails than they receive for handling express, but in proportion to the cost incurred by the roads and the value of the service rendered by them, the compensation they receive for handling the mails is less than that received for any other service.

The Railroad Clubs

CLUB	NEXT MEETING	TITLE OF PAPER	AUTHOR	SECRETARY	ADDRESS
Canadian	May 2	Annual Meeting and Smoker.		Jas. Powell	P. O. Box 7, St. Lambert, near Montreal
Central	May 12			d. D. Vought	95 Liberty St., New York
New England	May 9	Observations of Foreign Railways.	James F. Paige.	Geo. H. Frazier	10 Oliver St., Boston, Mass.
New York	May 19	The Possiblities of the Oxy-Acetylene Torch in the Railway Shop.	Prof. J. M. Morehead	H. D. Vought	95 Liberty St., New York
Pittsburg	May 26			C. W. Alliman	P. & L. E. R. R., Gen. Office, Pittsburgh, Pa.
Richmond	May 12			F. O. Robinson	C. & O. Ry., Richmond, Va.
St. Louis	May 12			B. W. Frauenthal	Union Sta., St. Louis, Mo.
Western	May 16	Annual Meeting and Election of Officers.		Jos. W. Taylor	390 Old Colony Bldg Chicago
Western Canada	May 8			W. H. Rosevear	100 Chestnut St., Winnipeg, Man.

ANNUAL MEETING.

NEW ENGLAND RAILROAD CLUB.

The twenty-eighth annual meeting of this club was held at the Copley Square Hotel, Boston, Mass., on Tuesday evening, March 14. The following officers were nominated for the ensuing year: President, J. A. Droege, superintendent, N. Y., N. H. & H. R. R.; vice-president, R. D. Smith, assistant superintendent motive power, B. & A. R. R.; treasurer, Charles W. Sherburne, 530 Lever St., Boston, Mass.; finance committee, B. M. Jones, 141 Milk St., Boston, Mass., and F. A. Barbey, South Station, Boston, Mass. The membership of the club was given at 533 and its prosperity is evident by the continued increase in membership and the amount of cash on hand, which by the treasurer's report is $2,283.24.

INFLUENCE OF GRAVITY ON TRAINS DESCENDING GRADES AND BRAKE POWER NECESSARY FOR SAFE CONTROL.

CENTRAL RAILWAY CLUB.

John P. Kelly at the March 10 meeting ably summed up the various factors entering into the above problem in one of the most instructive papers which have been presented before this club. The subject is one deserving serious consideration in view of the fact that in modern railroading the day of the hand brake has practically gone forever, and that dependence is placed entirely on the automatic brake to control the motion of trains on heavy long grades as well as on level road. Mr. Kelly's final conclusion was that the braking power now employed on modern freight equipment is none too high for safe operation on heavy grades; hence the need for keeping the brakes in the best of condition to insure sufficient braking or retarding power for safe handling.

TEAM WORK IN TRANSPORTATION.

CANADIAN RAILWAY CLUB.

The necessity of this important adjunct to successful railroad operation was emphasized by C. Murphy, general superintendent of transportation of the Canadian Pacific eastern lines at the April 4 meeting of the above club. It was pointed out that if the heads of the different departments are not working in harmony, it will be found that the employees of their departments are at cross purposes, which implies disorganization and serious increase in cost. On the other hand, where the heads of the different departments are working together with the one end in view—that of obtaining the best possible results, the same attitude is largely reflected by their subordinates and a combination so strong is formed that nothing can stand up against it, with the result that the lowest possible cost of operation is attained. Mr. Murphy reviewed in turn each of the various departments and indicated reforms which might be made tending toward the general good.

CAR INTERCHANGE.

WESTERN RAILWAY CLUB.

A paper on the above subject by T. W. Demarest, superintendent of motive power, Pennsylvania lines, was read at the meeting of this club held February 21. The presentation was largely an analysis of the M. C. B. code of rules, and contained the amended rules governing the interchange of cars at Chicago which will become effective when approved by the General Superintendents' Association.

CONSERVATION OF HUMAN LIFE IN STEAM AND ELECTRIC RAILROAD TRAVEL.

RAILWAY CLUB OF PITTSBURG.

At the February 24 meeting of this club Guy P. Thurber presented a rather lengthy paper under the above title, which, after a résumé of collision and mortality statistics, resolved into a description of the Gray-Thurber system of automatic train control and cab signal. It will be recalled that a trial demonstration of this system was made on the Pennsylvania Railroad west of Allegheny during 1905 to prove out the principle of automatically controlling trains successfully by using the well-known principle of the electro automatic block signal. Mr. Thurber described the various details at considerable length and in very interesting fashion. A considerable discussion was accorded the paper which was appreciatively received by the club members.

CONCRETE FOR RAILWAY WORK.

NEW YORK RAILROAD CLUB.

The varied uses to which this material can be adapted in connection with railroad structures were presented in a very interesting paper by J. P. H. Perry at the April 21 meeting of this club. It was pointed out that although railroad officials have adopted concrete most extensively for bridges, retaining walls, abutments, culverts, track elevation and similar heavy work, they have been somewhat backward about using concrete for buildings on their lines. The author recommended a more extensive application in this line, and set forth the varied advantages which it possesses, particularly from the viewpoints of fire and waterproofness, sanitary qualities and cost.

THE FIRST AUTOMATIC SIGNALS ON A STEAM ROAD using alternating current for operating and lighting the signals, as well as supplying the track circuits, were installed on the Cumberland Valley Railroad between Lemoyne and Mechanicsburg, a distance of seven miles, in 1908, and have just been put in service. No batteries are used on any part of the Cumberland Valley Automatic Signal System and the maintenance expense is limited chiefly to the proper lubrication of the signal mechanism, and the care of the rail bonds and insulated joints.

BOOK NOTES

Proceedings of the American Railway Bridge and Building Association. Twentieth Annual Convention, held at Denver, Colorado, October 18-20, 1910. Published by the Association. C. A. Lichty, Secretary, 215 Jackson Boulevard, Chicago, Ill.

The proceedings, which comprise 197 pages 6 by 9 inches, embody in detail the work of the convention. The secretary's report is of interest showing the association to be in a growing and prosperous condition, the membership having increased in numbers during the past ten years from 171 to over 400, including membership in Canada, Mexico, Australia, New Zealand, China, India, Cuba, Panama and the Philippines. Several extremely valuable papers were presented during the session, including Embankment Protection, Cast Iron Pipe Culverts, Buildings and Platforms for Small Towns, Superelevation on Bridges, Hoops for Water Tanks, and Fireproof Oil Houses. The attendance was large and the number and value of the papers, with the animated discussion accorded them, combined to render the convention as a whole one of the most successful in the history of the association.

Industrial Plants. By Charles Day. Cloth 294 pages, 5 x 7½ inches. Illustrated. Published by *The Engineering Magazine*, New York, N. Y.

The latest manner of arranging and planning industrial plants, based upon a logical scientific method of analysis, is the problem with which this book deals, and unquestionably the presentation of the subject is adequate, with a full realization of the author's aims. The factors considered by Mr. Day concern the organic constitution of the factory, and are of more potential importance even than systems of management, which concern functional conditions. While these latter may be remedied, organic inefficiency embodied in the design and structure of the plant is incurable, and is imposed upon all later operations. Mr. Day defines in this book for the first time, in permanent form, the principles and the practical precepts of scientific plant construction. Chapters I to VIII, inclusive, have to do largely with industrial principles, and the manner in which the planning of industrial plants should be conducted to incorporate these principles. Chapter IX treats of certain more important problems that enter into the metal working trades. Chapter X includes descriptions of the principal points of interest presented by a number of plants selected as illustrating the trend of modern progress, and chapters XI and XII bear upon the relationship of client and engineer. The development of the subject as presented is thorough and the book on the whole is a unique and valuable addition to such literature. The inclusion of a volume upon works construction in a library of "Works Management" is a purposeful recognition of the fact that efficiency and economy in manufacturing must be considered much more than the mere operation of the plant in which the processes of production are carried on.

Locomotive Breakdowns. By George L. Fowler and William W. Wood. Published by the Norman W. Henley Co., 132 Nassau St., New York, N. Y. Flexible covers, 270 pages, 4½ x 6½ in. Illustrated. Price, $1.00.

The seventh revised and enlarged edition of this exceedingly valuable book brings its subject matter strictly up to date, covering the latest developments in valve gears, superheaters and air brake practice. The chapter on questions and answers on the latter has been entirely rewritten, and is the result of long and careful study in selection, guided by years of experience. As this book is intended for the benefit of everyone in any way connected with the locomotive, the chapter on engine repairs is the premium to the shop and roundhouse men, illustrating a number of handy devices used in locomotive shop repairs, and while not coming within the scope of road emergencies, with which the book primarily deals, it may still be defined as of great value when time is an important element that demands instant recourse to the quickest means for effecting what practically amounts to emergency repairs.

PERSONALS

E. A. MOSELEY, secretary of the Interstate Commerce Commission, died at his home in Washington on April 18.

F. HUME has been made superintendent of machinery of the Fort Dodge, Des Moines & Southern R. R., at Boone, Ia.

GEORGE WORLING has been appointed master mechanic of the Gainesville Midland R. R., with office at Gainesville, Ga.

G. C. NICHOLS has been appointed master mechanic of the Jonesboro, Lake City & Eastern R. R., at Jonesboro, Ark.

C. A. WOOD succeeds C. W. Tessier as general foreman of the car department, National Railways of Mexico, at Aguas Calientes.

C. H. MONTAGUE has been made master mechanic of the Quincy, Omaha & Kansas City R. R., at Milan, Mo., vice A. W. Quackenbush.

D. L. RINGLER has been made roundhouse foreman of the Trinity and Brazos Valley Railway at Teague, Tex., vice E. L. Critz, transferred.

JAMES MCGINNIS, master boiler maker of the Santa Fe at Argentine, Kan., has been transferred to Topeka, Kan., with a similar position.

D. J. S. BROWN, assistance superintendent of motive power of the Delaware, Lackawanna & Western R. R., died on April 2, at Scranton, Pa.

Z. A. BURRELL has been made general foreman of the Atchison, Topeka and Santa Fe Ry. at Winslow, Ariz., vice A. J. Cunningham, resigned.

B. SMITH has been appointed general foreman of the Kansas City, Mexico & Orient locomotive shops at Wichita, Kan., vice Ira Chambers, resigned.

M. R. SMITH has been appointed master mechanic of the Monon shop at Lafayette, Ind., vice O. S. Jackson, resigned to accept service elsewhere.

N. KIRBY has been appointed master mechanic of the Alabama, Tennessee & Northern R. R., with office at Panola, Ala., succeeding D. D. Briggs.

JOHN C. O'DONNELL has been made machine shop foreman on the Atchison, Topeka & Santa Fe Ry. at Richmond, Cal., vice M. W. McKenna, resigned.

EDWARD HUGHES has been appointed purchasing agent of the Lehigh & New England R. R., with office at Lansford, Pa., succeeding J. B. Whitehead, resigned.

R. L. DOOLITTLE, master mechanic of the Atlanta, Birmingham & Atlantic R. R., at Fitzgerald, Ga., has been appointed superintendent of motive power of that road.

E. O. ROLLINGS, assistant master mechanic of the Louisville & Nashville Railway, at Howell, Ind., has been promoted to be master mechanic at South Louisville, Ky.

W. T. KUHN has been made assistant master mechanic of the Lake Erie & Western Railroad shops at Lima, O., succeeding G. J. Duffy, appointed master mechanic at the same point.

O. H. ATTRIDGE, general foreman of the Atlanta & West Point R. R. at Montgomery, Ala., has been made master mechanic of the system, vice F. O. Walsh, resigned to accept service elsewhere.

WILLIAM A. ELMENDORF, for many years connected with the Illinois Central R. R., died in Chicago on April 8. He is said to have placed in service the first sleeping car used on the above road.

J. MCCABE, formerly master mechanic at Harlem River, New York, New Haven & Hartford Railroad, has been transferred to New Haven as general road foreman of engines, vice E. W. Alling, promoted.

R. J. MCQUAID has been appointed a foreman in charge of locomotive and car departments of the Rock Island Lines, with office at Rock Island, Ill., succeeding V. W. Ellet, resigned, to go to the Hunt-Spiller Manufacturing Corporation, Boston, Mass.

J. L. WHITE, purchasing and supply agent of the St. Louis, Brownsville & Mexico. Ry. at Kingsville, Tex., has had his headquarters removed to Houston, Tex., and his jurisdiction has been extended to include the St. Louis & San Francisco lines in Texas.

E. W. ALLING, formerly general road foreman of engines, New York, New Haven & Hartford Railroad, with office at New Haven, Conn., has been promoted to master mechanic of the Old Colony Division; headquarters, Taunton, Mass., vice D. R. Killinger, resigned.

CATALOGS

TRAMRAILS IN FOUNDRY PRACTICE.—The Rockwell Furnace Co. of New York has issued Bulletin T, which is descriptive of the Moyer Tramrail, as applied to modern foundry practice. Several interesting half-tones graphically illustrate the uses to which this construction can be put, and in particular its labor-saving features, which commend it to special attention.

DIRECT CURRENT GENERATORS.—Bulletin No. 461, issued by the Triumph Electric Co., Cincinnati, O., is fully descriptive of the Triumph direct current engine type generators, which are furnished in capacities from 30 to 1,000 kw. The illustrated matter, which is extremely well selected and to the point, is remarkably clear, and the text is in a form very easily comprehended. The bulletin will be appreciated by the many interested in this class of machinery.

CAR HEATING AND LIGHTING.—The April issue of the Safety Heating and Lighting News, published by the Safety Car Heating and Lighting Co., of New York, N. Y., contains several very valuable illustrated articles on Pintsch mantle fixtures, corner berth lamps, and on the improvements of Pintsch mantle buoy lanterns. The object of the *News* is to place before railroad men matters of interest relating to lighting and heating railroad cars and allied subjects, and it is duly appreciated for the information which it contains.

GAS ENGINES.—A new 31-page catalog from the Bruce-Macbeth Engine Co., of Cleveland, Ohio, presents much valuable data in connection with the company's four-cylinder gas engine. The parts are taken up and described as they occur in the process of building, and the many accompanying half-tone illustrations of the various parts are a valuable addition to the text. The latter portion of the catalog contains some excellent photographs showing the application of the engines in connection with various manufacturing industries.

THERMIT WELDING.—The last number of "Reactions," the interesting quarterly publication by the Goldschmidt Thermit Co., of New York, N. Y., was devoted almost entirely to rail welding, but the present issue might well be called a crank shaft number. It illustrates and describes some particularly noteworthy repairs to this part which have recently been effected through the thermit process, and in addition to its usually artistic makeup, the paper is replete with a variety of valuable data. The locomotive section in particular will repay a perusal.

LOCOMOTIVE LUBRICATION is the title of an extremely interesting and valuable little book written by W. J. Schlacks, which is being distributed by McCord and Company, of Chicago and New York. The book deals graphically with lubrication of valves and cylinders and journals; discusses the various friction bearing metals, and treats at some length on methods of lubrication. An extensive description is accorded the system of force feed, and the efficiency of the latter is well set forth in the text and through numerous tabulated records of actual results attained in service.

FILES.—One of the most artistic catalogs to reach this office in a long period has just been received from the Nicholson File Company, of Providence, R. I., illustrative of this firm's well known output. The catalog contains 92 pages practically devoted in entirety to illustrated matter. The latter is intended to place before users and dealers a comprehensive display of all kinds of files now in common use. The illustrations show, first, Nicholson increment cut files and rasps, then Nicholson X. F. files, Swiss patterns, followed by several pages of manicure files, and tools and specialties, all manufactured by this company.

BALL BEARINGS.—The Hess-Bright Manufacturing Co., of Philadelphia, Pa., has issued four additional leaflets, Nos. 1-A, 2-A, 18-B and 34-A in the general series No. 336, supplementing its previously issued valuable information in similar form on the general subject of ball bearings. These sheets respectively illustrate and describe mounting for radial load without thrust, mounting for combined radial and thrust loads, mounting directions, and electric motor and two journal mountings. It is requested that former sheets 1, 2, 18, 18-A and 34, which these new issues supersede, be destroyed by those holding them in reference files.

RAILROAD ELECTRIFICATION.—In Circular No. 1517 the Westinghouse Electric & Manufacturing Co., of Pittsburg, Pa., has reproduced in the most artistic manner the series of talks and illustrations on the above subject which appeared in the technical magazines January 1 to March 1, 1911. This book is remarkable for the valuable information which it contains and equally so for the beauty of its many illustrations. The latter portray electric locomotives in actual service in the many localities, both at home and foreign, where Westinghouse installations have been made. It can be read with pleasure and profit by every railroad official.

THE JORDAN SPREADER.—A very interesting little booklet has been recently issued by the O. F. Jordan Co., Chicago, Ill., descriptive of the merits of the above well known device, which is generally recognized as the most efficient and durable of its kind in the country to-day. Long experience in building these machines and operating them in leveling, spreading and ditching all kinds of material in various climates and under all kinds of weather conditions, have made it possible to constantly add improvements and new features. The latest type of Jordan spreader, its construction and possible range of work, is well illustrated in the catalogue through a number of handsome half-tones. The description of the spreader is very complete and the catalog in general is replete with useful information concerning this device.

LEATHER BELTING.—The April number of *The Phoenix*, issued monthly by the New York Leather Belting Co., includes an exceptionally well executed photograph of fifteen of its experienced employes, not one of whom came with the company less than twenty years ago. One of the gentlemen pictured has seen forty-five years' service, and several have records of twenty-five years and over. The photo and the explanatory diagram occupy the middle facing pages of the paper and present an extremely attractive appearance. It was a happy conception well worked out, and is a graceful tribute to the long and faithful service of the experienced men who are necessarily past masters in the art of belt manufacture. *The Phoenix* contains its usual well assorted information on belt transmission and has several very interesting pictures of various belting applications.

CONTINUOUS RAILWAY FROGS.—The Continuous Frog and Crossing Co., of St. Louis, Mo., has put out a very handsome illustrated catalog describing the Roach frogs and crossings, of which they are the exclusive manufacturers. This device provides an uninterrupted tread surface for traffic at intersection of rails, for both main line and turn-out, embracing all the properties of safety of the track itself, as though it was continued through at this point without intersection. It is intended especially for high speed main tracks, where both tracks are used by trains at ordinary or high speeds. This new design of frog is a track structure in the full acceptance of the term, and absolutely accomplishes that which has been sought from the earliest history of railroading, a device that would provide a safe continuous tread, at turn-outs and crossings, without impact and without the use of guard rails.

ELECTRICAL MACHINERY.—The General Electric Co., of Schenectady, N. Y., has issued three bulletins of exceptional interest, dealing with the application of its products. In No. 4815 are illustrated and described continuous and alternating current motors, and apparatus for controlling them when applied to machine tool operations. Bulletin No. 4817 describes the company's 75 h.p. direct current commutating pole railway motor, which represents the latest construction in this class of apparatus. Bulletin B 3038 entitled "Electricity on the Farm," is a very artistic publication and is fully explanatory of the subject. The bulletin is attractively bound and carefully illustrated, and owing to the immense economic importance of the subject treated, should prove of considerable interest to the farmer, consulting engineer and central station manager.

NOTES

AMERICAN STEEL FOUNDRIES CO.—At their meeting in New York on April 12, the regular quarterly dividend of 1¼ per cent. was declared, payable May 15 to stockholders of record April 29.

AMERICAN LOCOMOTIVE CO.—The office of this company in Chicago was on April 8 moved from the Railway Exchange Building to Suite 907-912 McCormick Building, Michigan Boulevard and Van Buren street.

ATLANTIC EQUIPMENT CO.—The Chicago office of the Atlantic Equipment Company, on April 8th, 1911, was moved from Railway Exchange Building to Suite 907-912 McCormick Building, Michigan Boulevard and Van Buren street.

TRIUMPH ICE MACHINE CO.—J. F. Nisbet, publicity manager of the Triumph Electric Co., has been selected to take charge of the publicity and advertising department of The Triumph Ice Machine Co. also. These two departments were formerly operated independently of each other, but have now been combined.

JENKINS BROS.—After thirty years' continuous occupancy at 71 John street, New York, the business of these well known valve and packing manufacturers entirely outgrew the old home, and on April 17 removal was effected to the much larger building at 80 White street. The increased facilities afforded in the new location will no doubt enhance the perfect business service which it has always been the aim of the firm to render.

TRIUMPH ELECTRIC CO.—A. H. Whiteside, who was for over four years manager of the power and electrical department of the Allis-Chalmers Co., in charge of sales and engineering, has accepted a position as assistant sales manager with The Triumph Electric Co., of Cincinnati, Ohio. Mr. Whiteside was previously Southern manager of The Sterling Boiler Co., with headquarters at Atlanta, Ga. He is a member of the Engineering Club of New York, and an associate member of the American Institute of Electrical Engineers. He assumed his new duties on April 1. Also P. F. Pier, foreman of the transformer department of the Canadian General Electric Co., Peterboro, Ontario, has left that company to accept a similar position with The Triumph Electric Co. The Boston office of The Triumph Electric Co. has been removed from 101 High street to 92 Pearl street. Mr. C. A. Cotton is district office manager. This change of location was made necessary by the large increase in the volume of business and the necessity of having larger and more commodious quarters.

Developments in Superheating During the Past Year

S. HOFFMANN.*

Great strides forward have been made on American railroads in the introduction of superheated steam since the Master Mechanics' Convention of 1910, and a brief review of the tendencies developed and the experiences obtained might be appropriate. In the report of the Committee on Superheaters at the last convention, twenty American railroads were reporting on a total of eight hundred and five (805) superheater locomotives in service. European railroads reported on a little over five thousand locomotives in service or in course of construction. The number of superheater locomotives in Europe has since increased to about seven thousand, whereas, the number of locomotives equipped with superheaters in service or in course of construction on American railroads amounts now to approximately two thousand.

This rapid increase in the application of superheaters and the fact that some of the most important railroads, after extensive trials, are already specifying superheaters on all their new equipment and applying them to old power as well, indicates plainly that superheating cannot any longer be considered as being in an experimental stage.

Some of the railroads which during the past year ordered superheater engines are given in the following list:

Railroad.	Number of Superheater Locomotives Ordered.	Type of Engine.
Baltimore & Ohio R. R.	10	0880
Boston & Albany R. R.	1	2662
Boston & Albany R. R.	10	462
Canadian Pacific Railway	about 100	
Chesapeake & Ohio R. R.	24	2662
Chesapeake & Ohio R. R.	1	462
Chesapeake & Ohio R. R.	2	482
Chicago & Alton R. R.	20	282
Chicago, Milwaukee & St. Paul R. R.	2	460
Chicago, Milwaukee & St. Paul R. R.	5	280
Chicago & North Western R. R.	25	462
Chicago & North Western R. R.	30	280
Chicago, Rock Island & Pacific R. R.	50	462
Chicago, St. Paul, Minneapolis & Omaha	6	460
Chicago, St. Paul, Minneapolis & Omaha	2	462
Delaware & Hudson Railway	1	280
Delaware & Hudson Railway	1	460
Delaware & Hudson Railway	4	0880
Florida East Coast R. R.	5	462
Illinois Central R. R.	40	282
Illinois Central R. R.	5	462
Lake Shore & Michigan Southern Ry	20	462
Lake Shore & Michigan Southern Ry	10	280
Minneapolis, St. Paul & S. Ste. Marie	21	280
Minneapolis, St. Paul & S. Ste. Marie	16	462
Northern Pacific R. R.	18	462
New York Central & Hudson River R. R.	31	462
New York Central & Hudson River R. R.	25	2662
Pennsylvania Railroad Company	2	462
Pennsylvania Railroad Company	1	2882
Pittsburg & Lake Erie R. R.	5	460
Pere Marquette R. R.	25	280
Pere Marquette R. R.	5	462
St. Louis & San Francisco R. R.	12	280
Southern Railway Co.	58	282
Southern Railway Co.	2	462

This table clearly indicates that most of the superheaters have been applied to the more powerful types of engines, i. e., Mallet, Mikado and Pacific type engines. The steadily increasing demand for locomotives with increased hauling capacity requires boilers of increased steaming capacity and cylinders of larger diameter. Both requirements can be fulfilled by the application of the superheater, which not only increases the steaming capacity of the boiler averaging about 25 per cent., but at the same time permits the use of larger cylinders, because the superheat prevents the cylinder condensation.

In this manner the introduction of superheating opened a new field for further increase in power of these types of engines without overtaxing the capacity of the fireman. This is particularly the case with Mallet locomotives.

Two methods of superheating have been experimented with on Mallet engines: Superheating of the receiver steam in connection with a feed water heater, and the high degree superheating of the high pressure steam.

The first method has the disadvantage that it does not obviate the condensation in the high pressure cylinder, and that an intermediate superheater requires a considerably larger steam area than a high pressure superheater, in order to avoid wire drawing of the receiver steam. For this and other practical reasons in connection with the mechanical features of the receiver superheaters, only a few railroads have tried the application of the receiver superheaters. Most of the railroads use high degree superheating of the high pressure steam on Mallet locomotives. The superheat amounts to 200 degrees as an average, which is sufficient to give dry or moderately superheated steam on the low pressure side, but at the same time does not leave too much superheat in the low pressure steam to prevent the use of the ordinary slide valves on the low pressure cylinders. The application of superheaters to Mallet engines has been so much of a success from the start that practically all Mallet engines built during the past few months have been equipped with superheaters, and the application of a superheater is already almost considered as a necessary feature for an efficient Mallet engine.

Regarding the degree of superheat which is mostly favored on all types of engines there is a decided tendency noticeable toward the use of higher degrees of superheat, and averaging 200 degrees above the saturation point is the superheat generally considered as the most efficient. In this connection it should be remembered that the coal saving is not proportional to the degree of superheat, but increases more rapidly than the degree of superheat. This point has been very clearly brought forward in a paper on "Locomotive Performances Under Different Degrees of Superheat," read before the last Master Mechanics' Convention by Professor Endsley. On the other hand, actual experience with high degree superheaters has proven that, contrary to many predictions, the use of high degrees of superheat has not developed any serious trouble with lubrication.

With respect to the type of superheater mostly used, it can be said that more than 80 per cent. of the superheaters built during the period under consideration were of the fire tube type. This type seems not only to be favored on account of its efficiency in developing high degrees of superheat in an efficient way, but it is also preferred from a roundhouse point of view.

The essential requirements for an efficient and practical superheater are the accessibility of the superheater parts themselves and the location of the superheater in such a way that the rest of the boiler does not lose its accessibility; at the same time the superheater parts must be arranged in such a way so as not to cause wire drawing of the steam.

The steam and coal economy obtained with superheater locomotives, which is equivalent to a corresponding increase of the

* First Vice-President Locomotive Superheater Co., 30 Church street, New York.

boiler capacity, has made it possible in many cases to reduce the boiler pressure.

Quoting from a report of Prof. Goss on "The Use of Superheated Steam in Locomotive Service":

"Neither steam or coal consumption is materially affected by considerable changes in boiler pressure, a fact which justifies the use of comparatively low pressures in connection with superheat."

Most of the superheater passenger engines mentioned in the foregoing list carry boiler pressures of from 180 to 200 lbs., whereas for freight engines pressures between 160 and 180 lbs. have been favored. In bad water districts even lower pressures have been used with a corresponding increase in the diameter of the cylinders. On Mallet compound engines, however, the tendency is to maintain the boiler pressures of 200 lbs. and more, even with the superheater applied.

Contrary to the general conception no trouble has developed with lubrication in connection with the higher degrees of superheat. All engines built were equipped with ordinary sight feed lubricators, and on simple engines, as a general rule, five feed lubricators having two outlets to the steam chest and two outlets to the cylinders, have been applied. With regard to steam chest lubrication it is considered better practice not to bifurcate the oil pipe, but to let the oil enter into the steam cavity at the center of the steam chest.

One of the latest innovations in connection with the application of superheaters is the use of outside steam pipes. Most of the superheater engines built during the last few months have outside steam pipe connections to the cylinders. The following advantages of this arrangement are apparent:

No obstruction to the draft in the lower part of the smoke box; the joints between the steam pipes and cylinders are removed outside of the smoke box and any leakage occurring does not disturb the steaming of the engine, is easily noticed and remedied; the usual stresses in the cylinder saddle, due to the difference in temperature between live steam and exhaust passags are eliminated by removing the hot steam passage from the cylinder saddle.

These advantages of placing the lower part of the steam pipe outside of the smoke box are so appealing to the practical railroad men that it is safe to predict that the outside steam pipe connection will be a permanent feature of the American superheater locomotive.

The economical results obtained with superheater locomotives on several railroads showing savings in coal of 30 per cent. and more, would indicate that the application of superheaters to the larger sized American engines may even give better results than the superheaters applied on the smaller European engines. The larger size of cylinders causing increased losses through condensation may be one reason for this condition, and another may be looked for in the limit of the capacity of the fireman, which, on some American locomotives may already have been overreached, and caused uneconomical firing. This condition has been greatly improved by the coal and labor saving obtained by the use of superheated steam.

Among the many tests made during the year with superheater engines, one of the most reliable recently made with a Mallet engine equipped with fire tube superheater gave the following savings in coal:

DRY COAL PER DYNAMOMETER H. P. HOUR.

Speeds, Miles Per Hour.	Saturated Steam.	Superheated Steam.	Savings in %.
12.5	4.67	3.15	32.5%
15.0	4.75	3.56	25.0%
17.7	4.69	3.40	27.5%
Average	4.7	3.37	28.3%

These figures are the results of very careful tests where twenty-five trips were made on the same division of the road under conditions as nearly identical as possible, at first with the engine without superheater and afterwards with the same engine with the superheater applied.

Similar economical results have been obtained during the year with superheaters applied to passenger locomotives. But in the case of passenger engines it is not so much the coal saving which made these engines so successful, but the increase in power obtained and the better way in which the superheater engine handles the train. The great feature of the superheater locomotive is that its efficiency increases with the demand for power. If an ordinary engine without superheater is forced, its efficiency decreases on account of the increased wetness of the steam furnished by the boiler. The superheater engine, on the contrary, improves with increased demands, since the degree of superheat increases in proportion with the power the engine has to develop. In this connection the following quotation from the above mentioned report of Prof. Goss will be of interest:

"In operation the degree of superheat increases with the increased rate of power, which tends to conserve the steam supply as the demand for power is increased."

This flexibility is one of the main features which distinguishes the superheater engine from the ordinary simple engine and the compound engine; and is, besides the coal and labor saving, the principal cause why the superheater engines have in such a short time become a favorite with the men handling them.

THE TELEPHONE IN EMERGENCY SERVICE

The Delaware, Lackawanna & Western Railroad, besides being fully equipped for telephone train dispatching with the United States Electric Company's Gill selective system, has also in service the portable test sets for the use of its linemen, with the extension pole, whereby telephonic communication may be secured at any point on the line. With the portable telephone sets in the hands of men on the trains, the dispatcher, in the event of an accident, is enabled to talk with the man who knows all the facts in the case. Even if the man on the ground, by reason of the excitement incident to the emergency, overlooks some details or assigns to them minor importance, the dispatcher, having the greater experience, may, by his questions, elicit in conversation over the line, a detailed account of the situation which will serve as a basis for his action.

He will know whether to run the wrecker backward or forward, whether to approach the wreck with the crane ahead of or behind the engine, and whether the wrecked cars may be dumped off the right of way at the point of the accident, or will have to be dragged to some distant point. It is thus possible with apparatus now available, to place train crews in quick communication with the dispatcher in the event of any accident or emergency affecting normal train movements, irrespective of the location of the nearest permanent telephone station.

INTERESTING RAILWAY STATISTICS

Railway equipment in 1910 included 59,133 locomotives weighing 4,271,000 tons without tenders, 46,890 passenger cars, 2,134,000 freight cars of an average capacity of 35 tons, and 104,093 company's cars. Since 1907 number of freight cars has increased less than 100,000, but there has been increase of one ton per car in average capacity.

June 30 reports to the Bureau of Railway News and Statistics gave number of railway employees 1,684,238, and compensation for year $1,137,016,508. This warrants an estimate of 1,754,400 employees for all railways, whose compensation was $1,172,181,000, being largest payroll in their history by over $100,000,000, and this before advances of last spring were fully in operation. Labor in 1910 received 42 per cent. of gross earnings. In five years since the bureau began its record average daily pay of all railway employees has increased from $2.07 to $2.29. Since 1894 average daily compensation of railway enginemen has increased 27.1 per cent., of firemen 35 per cent., of conductors 29.2 per cent., and of "other trainmen" 43.9 per cent. Increase for all classes was approximately 26 per cent.

LOCOMOTIVE BUILDING IN SCOTLAND is said to have been far from active during the past year. Some of the works have been kept going with difficulty, while about 1,000 fewer hands have been employed than during the previous year.

Saving by Oxy-Acetylene Welding

LAKE SHORE & MICHIGAN SOUTHERN RAILWAY.

CAREFULLY KEPT RECORDS OF THE WORK PERFORMED BY THE OXY-ACETYLENE WELDING APPARATUS, IN USE AT THE COLLINWOOD SHOPS, HAVE SHOWN SOME VERY SURPRISING MONEY-SAVINGS RESULTING FROM THE GENERAL AND VARIED USE OF THE APPARATUS FOR MANY PURPOSES AT FIRST UNTHOUGHT OF.

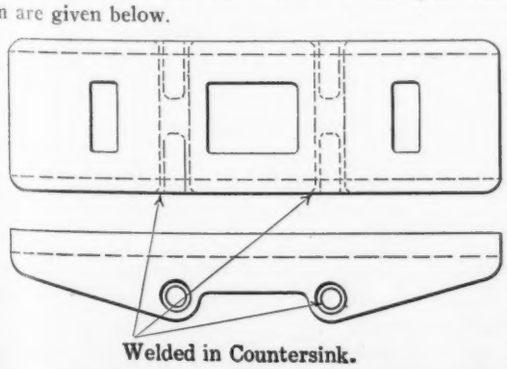
About two years ago there was installed at the Collinwood shops of the Lake Shore and Michigan Southern Railway an apparatus for welding steel and iron by the Oxy-Acetylene process. It consists of a stationary type generator in which acetylene is produced by the automatic feeding of calcium carbide into water, the necessary supply of oxygen being obtained in cylinders which, therefore, do not form a part of the permanent equipment. The complete equipment was furnished by the Linde Air Products Co.

The acetylene generator has a carbide capacity of 150 pounds, the acetylene being generated under a pressure of about 5 ounces per square inch. The oxygen is obtained in cylinders each containing 100 cubic feet under a pressure of 1,800 pounds per square inch. This pressure, however, is reduced when the apparatus is in use to about 18 pounds per square inch at the point where it enters the blowpipe, by means of an automatic pressure regulator, attached to the oxygen cylinder. The blowpipes are of the well-known Fouché type. The acetylene generating apparatus, as above stated, is of the stationary type, but it is mounted upon a platform so arranged that it can be lifted by the cranes and transported to different parts of the shop. As the oxygen cylinders can be trucked, so far as the interior of the shop is concerned, the apparatus is practically portable. This permits it to be taken to the erecting shop and work performed on locomotives which are on the pit, or it can be taken to the boiler shop and repair fire boxes, flue sheets, etc., without having to transport the boiler or use a complicated and extensive system of piping to carry the gases.

The longer this apparatus has been in use the greater has been the variety of work for which it has been found suited until at the present time the many ways in which acetylene welding can be used to advantage is really surprising. Possibly the most valuable use of the apparatus in a railroad shop is for putting in patches or welding cracks in fire box sheets, and at Collinwood it is very extensively employed in this way with most satisfactory results.

Some time ago it was decided to keep a record of the work which is being done by this apparatus for a period of time. Forms were prepared to show the gas consumption, time required, number of men, etc., as well as the expense of obtaining the same results if the welding apparatus was not available. A man was detailed to follow the machine for this purpose and sketches were made showing exactly the kind of work performed.

These reports are now very extensive, inasmuch as the machine is in almost constant use and a few examples selected at random are given below.



Welded in Countersink.

FITTED PLUGS WELDED INTO CAST STEEL CROSSHEAD SHOES. The holes are countersunk about ¼ in. deep. Plugs are fitted and driven into holes, then welded in countersink using No. 10 Swedish iron wire for fusion. The holes are then re-drilled. This saves replacing with new castings, as has been customary.

The total cost of welding each shoe is as follows:

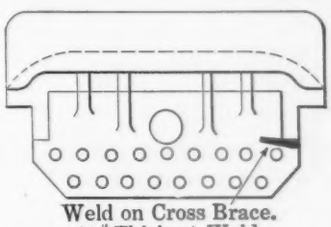
¾ of an hour labor at $.50½ =.....	$ .38
30 ft. gas, carbide and wire =.....	.60
Total cost of welding =.....	$ .98

Comparing this cost with the cost of replacing this casting, the following figures show a saving by welding process (scrap value has not been considered).

New Casting:		
Material	$2.50	
Labor	.35	
Total		$2.85
Total cost of welding.....		.98
Total saved by welding process.....		$1.87

WELDING CAST STEEL FURNACE BEARER.

The following weld of a crack 5 in. long was performed on engine 5871. The crack was chipped out in the form of a "V"



Weld on Cross Brace.
1½" Thick at Weld.

the entire length. The same method and welding was used as in welding a firebox seam.

The total cost of labor and material for repairing the above fracture was as follows:

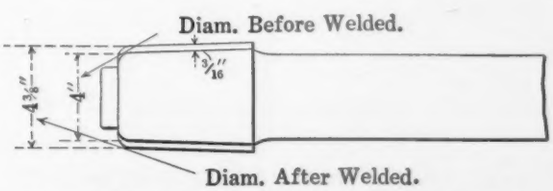
2 hrs. at $.50½ per hour =.....	$1.01	
40 ft. gas and carbide =.....	.70	
Total cost of welding.....		$1.71

Comparing the cost of welding with the cost of renewing the above casting, the following figures show the saving:

Cost of New Casting:		
Material	$47.17	
Labor	11.91	
		$59.08
Cost of welding.....		1.71
Saved by welding.....		$57.37

LAYER WELDED ON END OF PISTON ROD.

The end of the rod is heated in a forge and then the layer

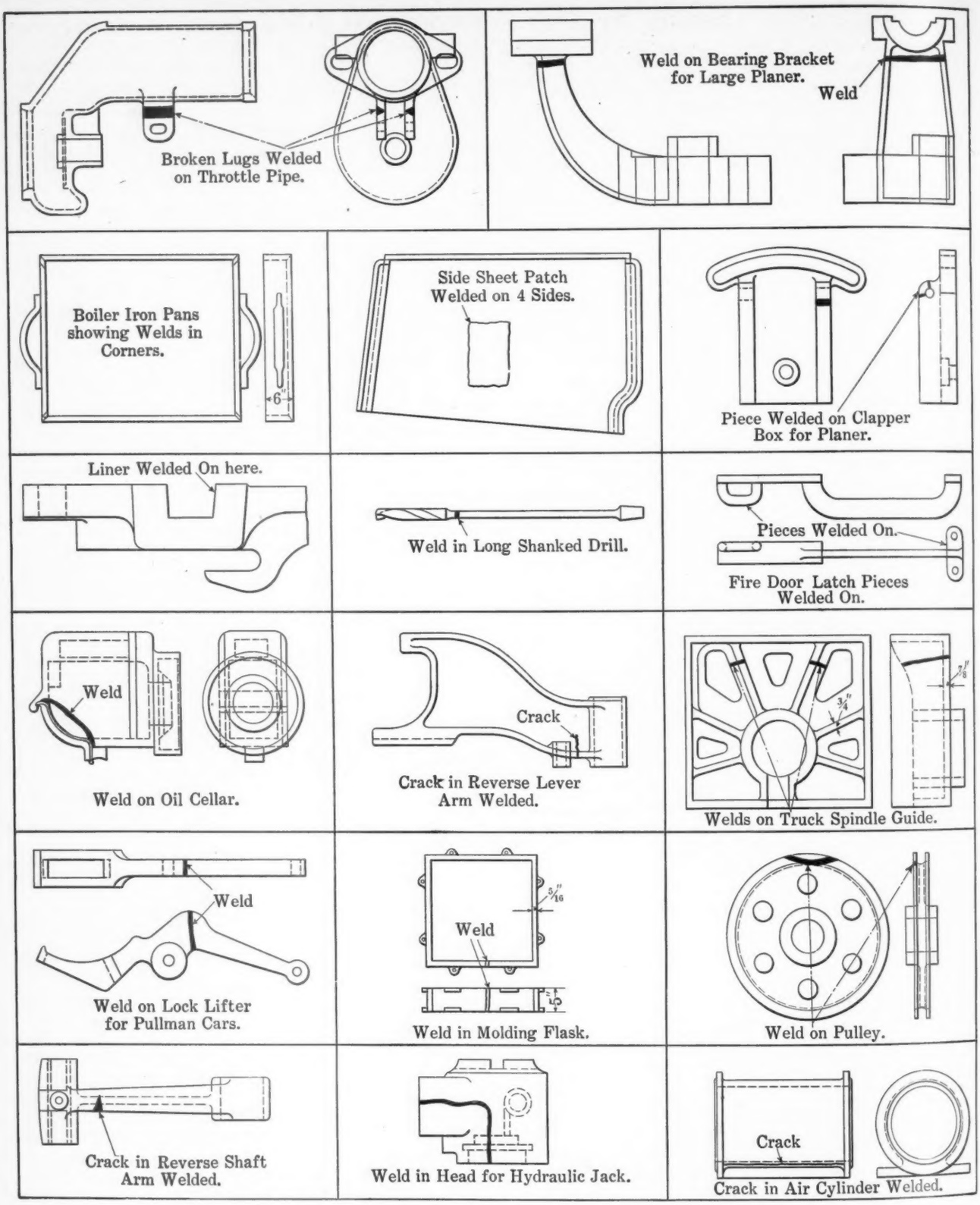


Layer 3/16" Thick on Cross-head End of Piston Rod.

is welded on the full circumference and length of the fit, and as thick as necessary. No. 10 Swedish iron wire being used for fusion.

Total cost of welding was as follows:

2½ hours of labor at $.50½ =.....	$1.26	
90 ft. gas, carbide and wire.....	2.00	
		$3.26



EXAMPLES OF WORK DONE BY THE OXY-ACETYLENE WELDING PROCESS AT THE COLLINWOOD SHOPS.

Under the old method of scrapping all rods worn below size, the cost of labor and material was as follows:

Labor	$2.24	
Material	3.00	
Total cost of new rod		$5.24
Total cost of welding		3.26
Total saving		$1.98

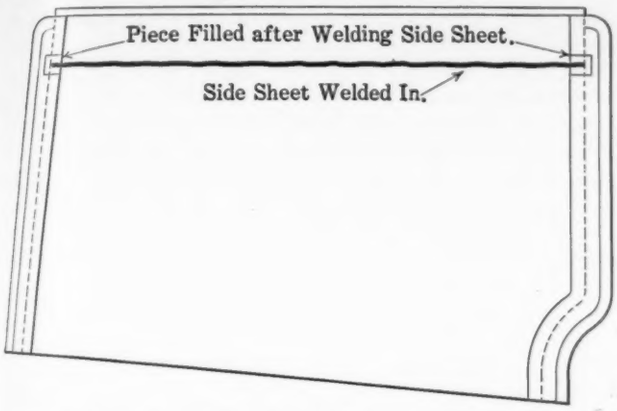
WELDING SIDE SHEETS TO CROWN SHEET.

The edges of the sheets to be welded are first beveled at an angle of 45 degs., then put in position and held on by means of temporary bolts through the outside sheet in such a way that the sharp edge of the bevel joints form a "V" shaped groove on the inside of the firebox.

A Fouché injector blow pipe is used, starting at one end, the seam is heated to the fusing point, and No. 10 Swedish iron wire run in for fusion.

This process is carried steadily forward until the end of the seam is reached. The metal, at frequent intervals, surrounding seam is heated to a cherry red and hammered. This relieves the strain due to uneven contraction of the metal.

On engine No. 5818 both side sheets were welded in. The length of one side seam being 102 in.



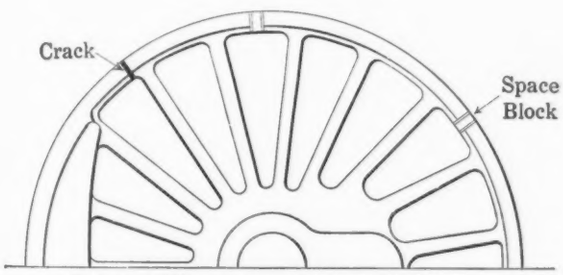
The following is an itemized cost of the above weld:

Labor—18 hrs. at 50½c. per hr. =.....	$9.09
Material—380 ft. gas, carbide =.....	6.91
	$16.00

After welding no roundhouse repairs are necessary, such as caulking, replacing rivets, etc., and it is considered that the welded joints soon pay for themselves in this way.

SPACE BLOCKS.

The following figures show the total cost of welding 24 space blocks into the driving wheels of engine 4692:



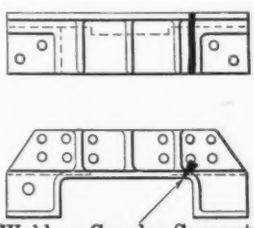
Driving Wheel Space Blocks Welded in. Also Crack in Rim Welded.

16 hrs. labor at $.50½ =.....	$8.08
380 ft. gas, carbide and wire =.....	7.00
Total cost of welding.....	$15.08

Clearance in the form of countersink is chipped out on each side of block for welding, No. 10 Swedish iron wire being used for fusion. This insures against the old trouble of losing these blocks, which occurred frequently while engine was in service.

COUPLER SUPPORT FOR TENDERS.

The same welding material is used as when welding front furnace bearer, as they both are cast steel.



Weld on Coupler Support and Spring Case on Tenders.

The total cost of welding this casting is as follows:

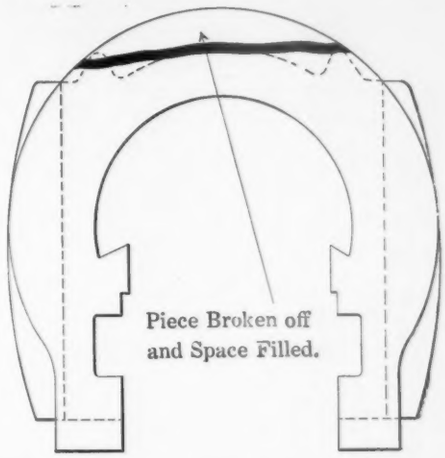
4 hours of labor at $.50½ per hr. =.....	$2.02
60 ft. gas, carbide and wire =.....	1.25
Total cost of welding =.....	$3.27

Under the old plan of scrapping these castings and furnishing new ones, the cost would be $10.23, including machine work. The saving effected therefore is $6.96.

DRIVING BOXES.

Piece of driving box was broken off and the space was filled up, as shown in the sketch.

The same method and material are used as when welding a



layer on piston rod, filling space up by using No. 10 Swedish iron wires as a fuse.

The total cost of welding this casting is as follows:

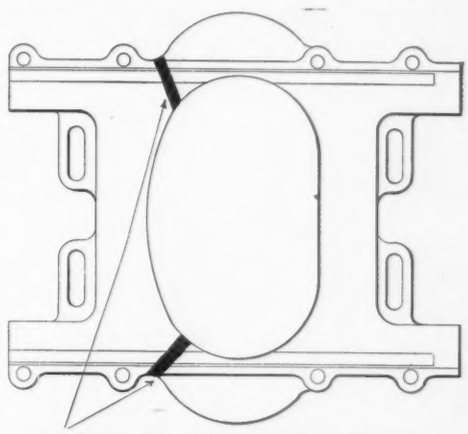
3½ hrs. of labor at $.50½ =.....	$1.77
65 ft. gas, carbide and wire.....	1.40
Total cost of welding.....	$3.17

Under the old plan of scrapping boxes in this condition and furnishing new ones, the cost was $23.05, including machining. This method thus shows the following saving:

Cost of new casting.....	$23.05
Cost of welding.....	3.17
	$19.88

FRANKLIN FIRE DOOR.

The material is cast iron and in welding cast iron a special



Welds on Franklin Fire Door Frame.

cast iron alloy is used in conjunction wth Feroflux.

The cost of welding is as follows:

9½ hrs. of labor at $.50½ per hr. =.....	$4.80
80 ft. gas, carbide and wire =.....	1.60
Total cost of welding.....	$6.40

The saving made in this case is as follows:

Cost of new casting.....	$12.00
Cost of welding.....	6.40
	$5.60

WELDING BROKEN LUGS ON CASE OF 5 H.P. MOTOR.

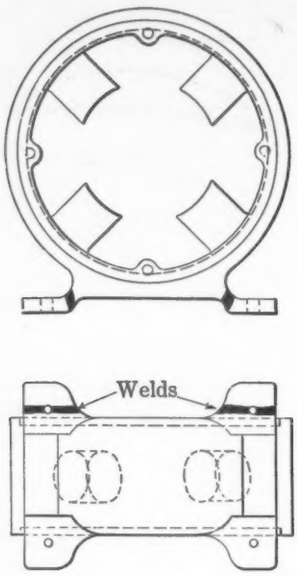
The same method and material is used as in welding the Franklin Fire Door, as they both are cast iron.

The total cost of welding is as folows:

3 hrs. at $.50½ per hr. =.....	$1.52
45 ft. gas, carbide and wire =.....	.73
Total cost of welding =.....	$2.25

Under the old plan of scrapping broken cases and furnishing new ones the cost would be $100, showing a saving of $97.75.

Among the other pieces of work done during the past few months a few somewhat unusual jobs noticed in the reports are



as follows (some of these are shown in the accompanying illustration):

Liners welded on pedestal braces.
Pressed steel body bolster repaired.
Fire door latch repaired.
Water tight pan made from boiler iron.
Cracked reverse lever arm repaired.
Broken mould flask repaired.
Ventilator frame welded.
Letter press repaired.
Excess metal in cylinder steam passages removed.
Cracked reverse shaft arm repaired.
Crack in corner of pedestal repaired.
Spoiled main rod reclaimed.
Lug on coach trap door repaired.
Various broken parts of machine tools repaired.
Coupler lug lifter repaired.
Various heavy cast steel and iron parts of locomotives reclaimed and repaired.
Head of hydraulic jack repaired.
Tank well gooseneck repaired.
Broken injector parts repaired.
Broken long shanked drill welded.
Scale lever repaired.
Sand holes in casting filled up.
Broken wrenches repaired.
Broken vise jaws welded.
Broken crane pulley repaired.
Broken journal box repaired.
Car jacks repaired.
Lugs welded on throttle pipe.

PROPOSED BALANCED SIMPLE 4-6-2 TYPE LOCOMOTIVE OF MAXIMUM POWER

W. E. JOHNSTON.

Owing to the increase in the weight of trains and consequent demand for more power, the possibility of securing greatly increased capacity in locomotives of the Pacific or 4-6-2 type by the use of the four-cylinder balanced principle would seem to be of even greater importance than the well-known advantages of smooth running and ease on track in the case of lighter locomotives.

The maximum tractive effort of two-cylinder locomotives of the 4-6-2 type is about 35,000 lbs., leaving a considerable gap between these designs and the 4-4-6-2 type with about 53,000 lbs. tractive effort now in service on the Santa Fe.

The design herein proposed is an attempt to secure maximum capacity for very heavy medium speed passenger service in a balanced locomotive of the 4-6-2 type without exceeding safe wheel loads or including any such undesirable features as bifurcated main rods or inclined cylinders. With suitable modifications this design may be made to give any desired tractive effort between 35,000 lbs. and 50,000 lbs. and meet any reasonable requirements as to speed.

While 200,000 lbs. on three pairs of drivers and a tractive effort of 47,600 lbs. may at first seem excessive, the maximum stresses in the track for this locomotive are actually less than frequently occur with ordinary two-cylinder locomotives.

Assuming, as a basis of calculation, a two-cylinder 4-6-2 type locomotive with about 150,000 lbs. on drivers as about the maximum for ordinary track, the excess counterbalance at crank radius figured by the Master Mechanic's formula will be about 200 lbs. to 250 lbs. per wheel. At a speed in miles per hour equal to the diameter of the drivers in inches and with a 26 in. stroke, the centrifugal force is 41.73 times the weight. For 200 lbs. excess counterbalance per wheel, the centrifugal force (w) is 8,346 lbs. per wheel or, approximately, 50,000 lbs. for six wheels. For 250 lbs. excess counterbalance, the centrifugal force per wheel is 10,432 lbs. per wheel or, approximately, 62,000 lbs. for six wheels. In Fig. 1, the vertical components of these forces which are effective in increasing or diminishing the pressure on the rail have been laid out for one revolution of a wheel starting and ending with the counterbalance on the horizontal center line, at which point the vertical component of the centrifugal force of the excess counterbalance is zero.

Taking the lower value of 200 lbs. excess counterbalance in order to be well on the safe side, we will have a total load of 150,000 plus 50,000 lbs., or 200,000 lbs., on the rails when the counterbalances are on the bottom quarter. Now, if the track can sustain a pressure of 200,000 lbs. from six drivers at one point, it can also at another or at all others, and 200,000 lbs. on six drivers on a balanced locomotive will be no more liable to damage the track than 150,000 lbs. on six drivers on an ordinary two-cylinder locomotive running at a speed in miles per hour equal to the diameter of the drivers in inches. As a matter of fact, passenger locomotives frequently exceed this speed and at extreme high speeds the wheel loads on the balanced locomotive which are not affected by the speed would be materially less than on the two-cylinder locomotive on which the centrifugal force of the excess counterbalance increases as the square of the speed.

As stated previously, the design proposed is intended for

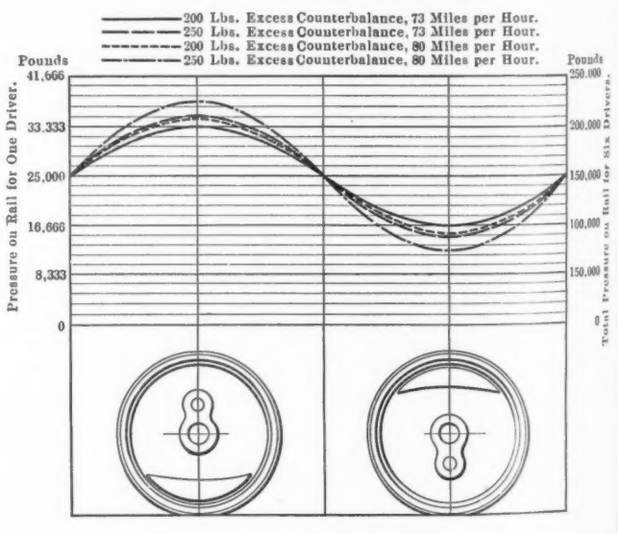


FIG. 1.

medium speed passenger service and therefore 73 in. drivers have been figured on. Also assuming that the locomotive will be required to start heavy trains, as high tractive effort as the weight on drivers will permit is desirable, say about 45,000 to 50,000 lbs., giving ratios of weight on drivers to tractive effort of 4.44 and 4.00 respectively.

The diameter of the inside cylinder is limited to about 18 in. by the space available between the frames. 18 in. x 26 in. cylinders with 175 lbs. boiler pressure and 73 in. drivers give a tractive effort of 17,150 lbs., leaving a balance of about 30,000 lbs. to be developed by the outside cylinders. 24 in. x 26 in. cylinders with 73 in. wheels and 175 lbs. boiler pressure give 30,450 lbs. tractive effort. Then a four-cylinder balanced simple locomotive with 18 in. and 24 in. x 26 in. cylinders, 73 in.

drivers and 175 lbs. boiler pressure will develop 17,150 plus 30,450 = 47,600 lbs. tractive effort, and the ratio of weight on drivers to tractive effort will be 4.2, which will be satisfactory.

All previous designs of four-cylinder balanced simple locomotives, as far as records are available, have had all four cylinders of the same diameter. This is not essential, however, as it is not necessary to balance the power developed in the inside and outside cylinders. The special and essential feature of the four-cylinder balanced locomotive is the balancing of the reciprocating weights, and this may be done with cylinders of different sizes by making the large piston as light as possible and adding to the small piston, or its crosshead, whatever weight is required to make the reciprocating weights for the large and small cylinders equal.

Having determined the weight on drivers and the tractive effort, the next step is to provide a boiler of sufficient capacity to supply the cylinders at the speeds required.

Fig. 2, the general plan of the locomotive, shows a boiler 80 in. in diameter at the first ring and 92 in. in diameter over the largest course, which will contain about 250 2¼-in. tubes and 27 5⅜-in. tubes 21 ft. 0 in. long. The distance of 4 ft. 6 in. from center of the cylinder to front tube sheet will give ample space for the superheater header without obstructing the draft. The 3 in. 0 in. combustion chamber with 21 in. 0 in. flues and 4 in. 6 in. from center of cylinder to front tube sheet and the sloping throat sheet give ample clearance over the rear drivers. A superheater has been included and is of such dimensions as will probably give about 150° F. superheat and about 20 per cent. saving in water consumption.

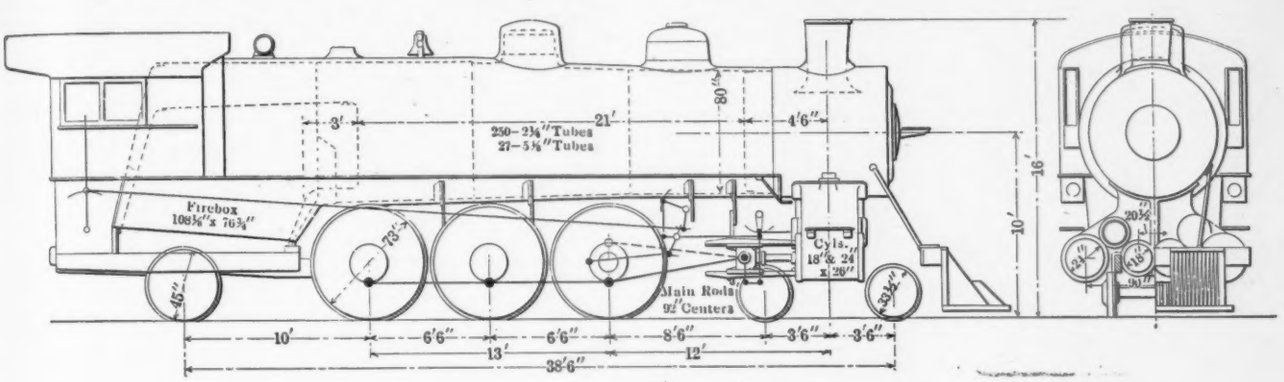


FIG. 2.

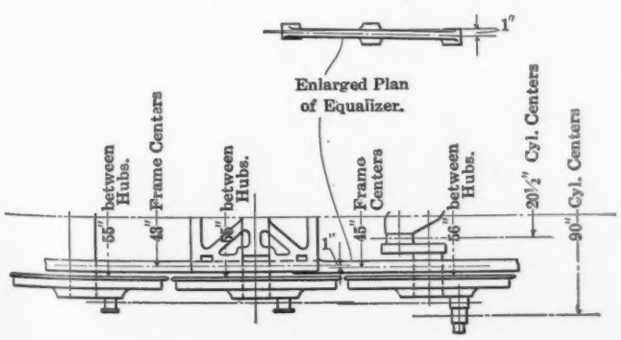


FIG. 3.

In order to promote free circulation, ⅞ in. bridges between the 2¼-in. tubes and 1¼-in. bridges between the 5⅜-in. tubes have been used, although considerably more heating surface could have been obtained by closer spacing. The ratio of tractive effort times diameter of drivers to heating surface and of heating surface to cylinder volume compare favorably with a number of recent superheater locomotives and indicate satisfactory steaming qualities. The fact that the combustion chamber is practically equivalent to an equal length of tubes should be considered in connection with the ratios involving heating surface.

One of the principal difficulties in a four-cylinder balanced locomotive of the 4-6-2 type has been to secure a sufficient length of main rod without using inclined cylinders or bifurcated rods in order to clear the front axle. In this design, this has been taken care of by making the distance from the front driver to the center of the cylinders 12 ft. 0 in., which permits a 92-in. main rod connected to the front drivers.

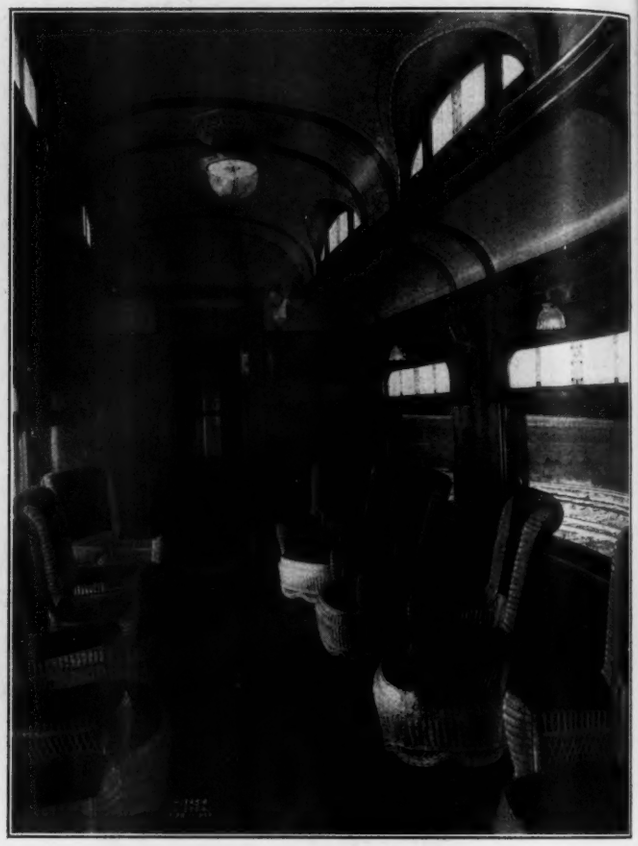
In order to get as large inside cylinders as possible, the distance between hubs on the front drivers has been made 56 in. with 13 in. diameter by 11-in. journals and 45-in. frame centers. Each frame is offset 1 in. between the front and middle drivers, giving 43-in. frame centers, 12 in. x 12 in. journals and the Master Mechanic's standard distance of 55 in. between hubs on the middle and back drivers. Whatever strains may be caused by the offset in the frames can be more than amply provided for in the cast steel crosstie over the middle axle and the waist sheets extending up to the boiler. To keep the load from the springs central on the driving boxes, the equalizer between the front and middle drivers is also offset 1 in. as shown to an enlarged scale in view Fig. 3.

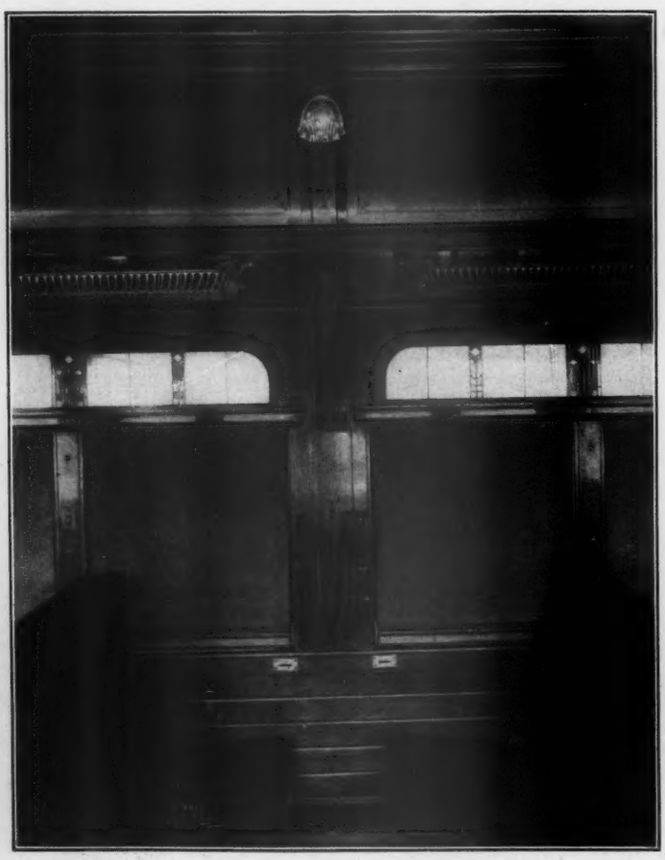
The following table gives the principal dimensions of the proposed design:

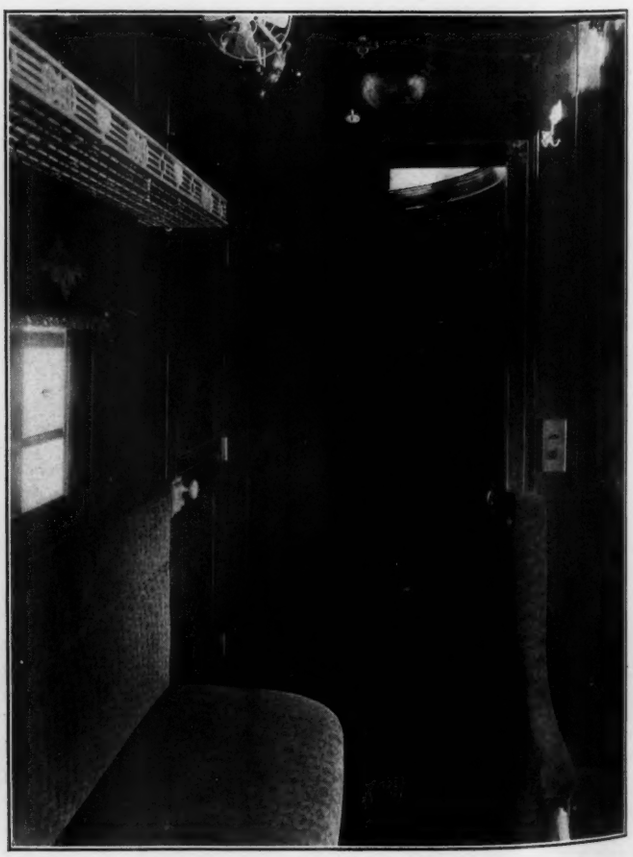
GENERAL DATA.	
Type	4-6-2
Fuel	Bituminous coal
Tractive effort	47,600 lbs.
Weight in working order	285,000 lbs.
Weight on drivers	200,000 lbs.
Wheel base, driving	13 ft. 0 in.
Wheel base, total	38 ft. 6 in.
RATIOS.	
Weight on drivers ÷ tractive effort	4.2
Total weight ÷ tractive effort	6.0
Tractive effort times diam. drivers ÷ evaporating surface	830.0
Tractive effort times diam. drivers ÷ *equivalent heating surface	680.0
Volume, 4 cylinders	21.22 cu. ft.
Evaporating surface ÷ vol. cylinders	197.0
Equivalent heating surface ÷ vol. cylinders	241.0
Grate area ÷ vol. cylinders	2.66
CYLINDERS.	
Kind	Four-cylinder balanced simple
Diameter and stroke	18 in. and 24 in. x 26 in.
VALVES.	
Kind	Piston
Diameter	12 in.
WHEELS.	
Driving, diameter over tires	73 in.
Driving journals, front	13 x 11 in.
Driving journals, middle and back	12 x 12 in.
Engine truck wheels, diameter	33½ in.
Engine truck journals	6½ x 12 in.
Trailing truck wheels, diameter	45 in.
Trailing truck journals	8 x 14 in.
BOILER.	
Style	Extended wagon top
Working pressure	175 lbs.
Outside diameter of first ring	80 in.
Firebox, length and width	108⅛ x 75¼ in.
Tubes, number and outside diameter	250—2¼ in., 27—5⅜ in.
Evaporating surface, tubes	3,890 sq. ft.
Evaporating surface, firebox	300 sq. ft.
Evaporating surface, total	4,190 sq. ft.
Superheating surface	620 sq. ft.
Grate area	56.3 sq. ft.
Smoke stack, height above rail	16 ft. 0 in.
Center of boiler above rail	10 ft. 0 in.

* Evaporating surface + 1½ times superheating surface.

PLAIN FACTS connected with business do not count for much against fixed opinions.—*David Van Alstyne before the Congress of Technology, Boston, Mass.*







GENERAL INTERIOR VIEWS OF STEEL PASSENGER EQUIPMENT ON THE CHICAGO, MILWAUKEE AND ST. PAUL RAILWAY.

Steel Passenger Train Equipment

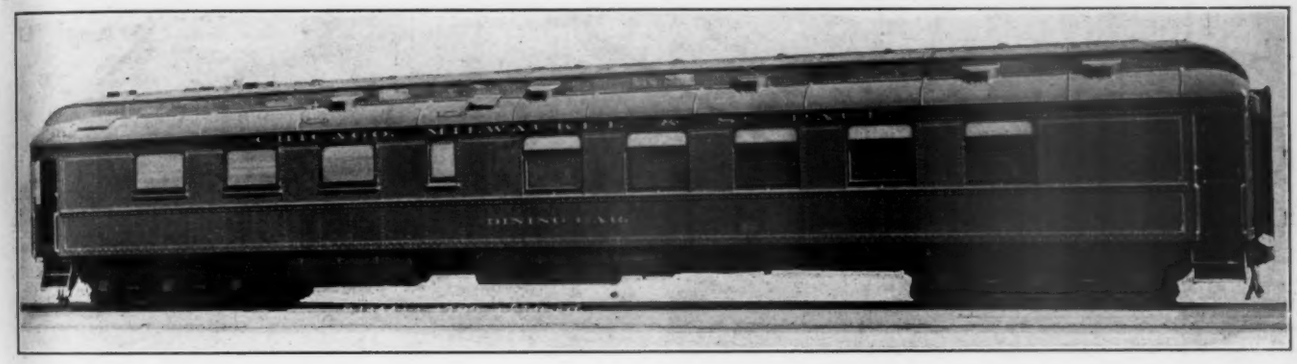
CHIGAGO, MILWAUKEE & ST. PAUL RAILWAY.

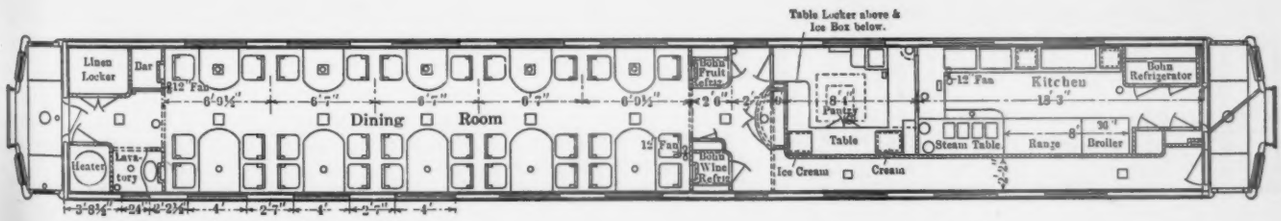
ON ELEVEN DIFFERENT KINDS OF PASSENGER TRAIN CARS OF COMPOSITE CONSTRUCTION RECENTLY BUILT FOR THE CHICAGO, MILWAUKEE & ST. PAUL RAILWAY, A STANDARD ALL STEEL UNDERFRAME HAS BEEN EMPLOYED. MANY OTHER OF THE STEEL PARTS OF THESE CARS ARE ALSO STANDARD, RESULTING IN NOT ONLY A REDUCED INITIAL COST BUT ALSO IN GREATLY FACILITATING REPAIRS.

The recent inauguration of through passenger trains from Chicago to the Pacific Coast over the Chicago, Milwaukee & St. Paul, with its new extension, the Chicago, Milwaukee & Puget Sound Railway, is of particular interest on account of the exceptionally high character of the passenger train equipment which is being put into service. There has never been a new railroad of this size put into operation on which equipment of this class, and to the extent here employed, has been used. This company has received 243 steel passenger train cars divided up as follows:

84 coaches
40 twelve section drawing room, smoking room sleepers.
28 baggage cars.
20 diners.
18 ten section two compartment sleepers.
18 tourist sleepers.
18 baggage and mail cars.
4 parlor cars.
2 all compartment sleepers.
9 buffet observation cars.
2 chair cars.

The main body of all of these cars, with the exception of the baggage and mail cars, which are 60 ft. 11 in. long, is 72 ft. 6 in. long. They all employ the same underframe and the same superstructure, except as the window and interior arrangement has made changes necessary in the latter.

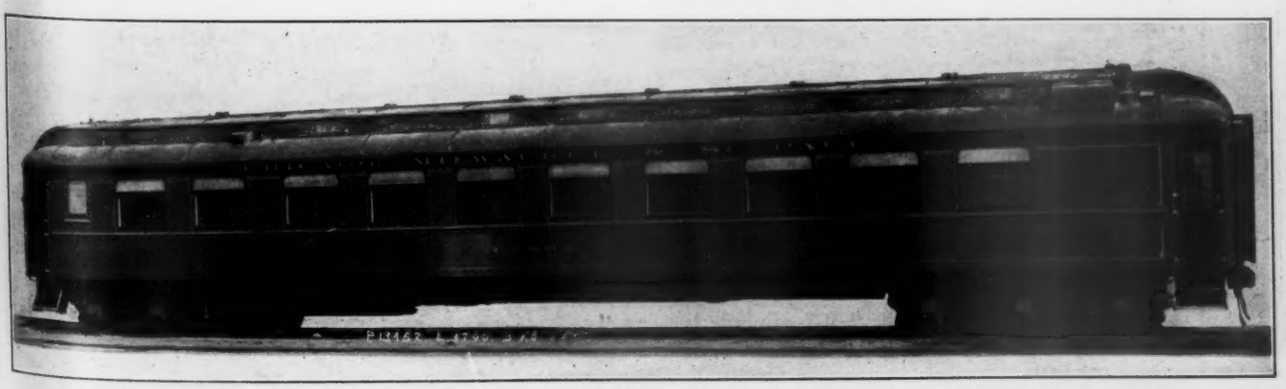




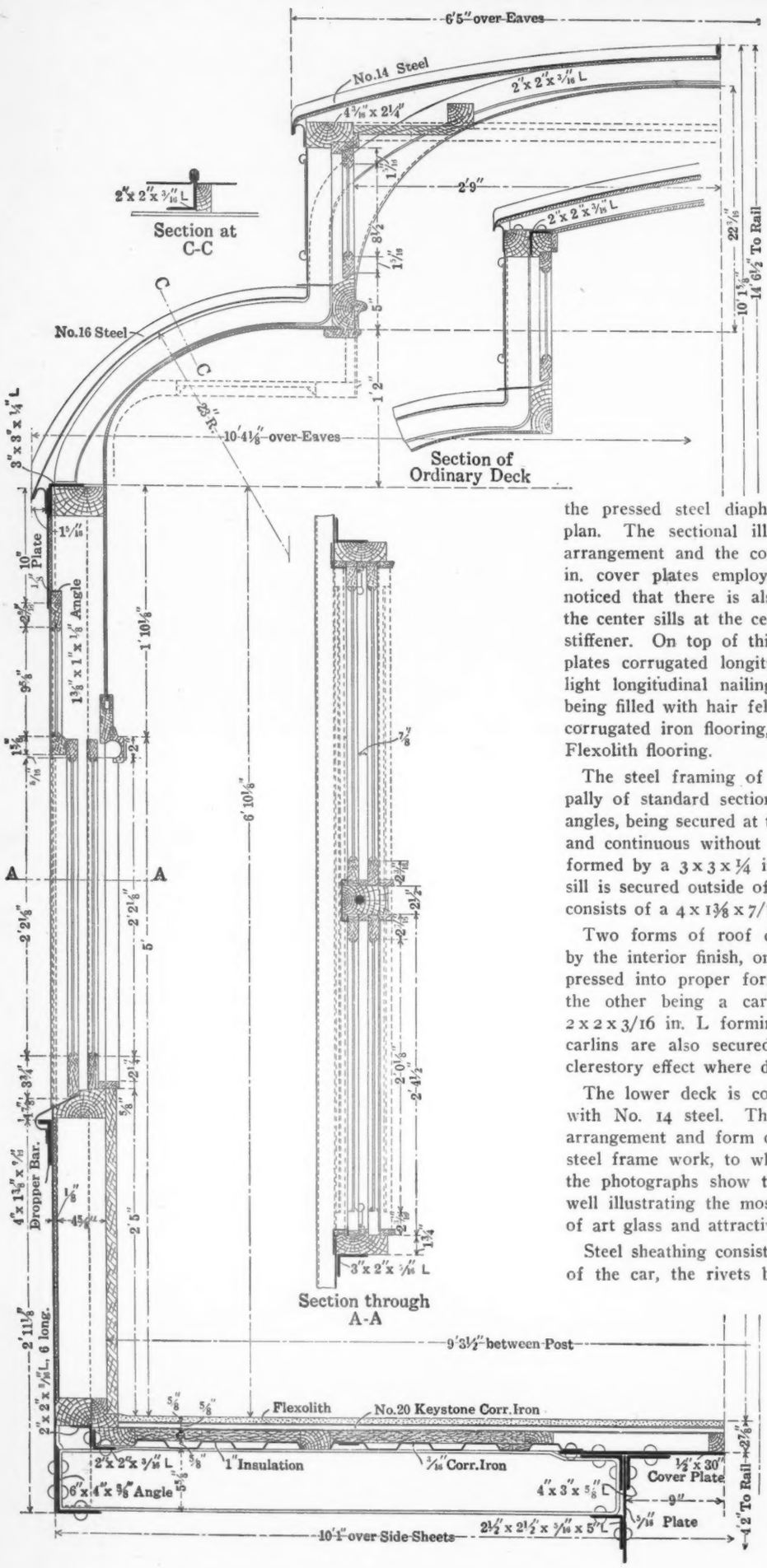
EXTERIOR VIEW AND FLOOR PLAN OF NEW STEEL DINERS—C., M. & ST. P. RY.

These standard underframes are very similar and somewhat heavier than the standard frame adopted by the Pullman Company for this equipment,* and consist of two plate girder fish belly center sills connecting the steel castings making up the entire underframe structure from the bolster to the platform sills. These center sills are built up of 5/16 in. plate, 2 ft. 2 in. deep between cross bearers and spaced 18 in. apart. The compression members consist of two 4 x 3 x 5/8 in. angles riveted at the top of the web plate, while the tension members are

* For full illustrated description see AMERICAN ENGINEER AND RAILROAD JOURNAL, October, 1910, page 381.



COMPOSITE STEEL PARLOR CAR—C., M. & ST. P. RY.



SECTIONAL ELEVATION SHOWING DETAIL OF FRAMING.

two 3 x 3 x 3/8 in. angles riveted at the bottom of the plate. There is a continuous top cover plate 30 x 1/2 in. covering both sills. These sills differ from the Pullman design only in the greater depth at the center, being 26 in. as compared with 22 in. The deepest section is uniform between needle beams, which in the case of the Milwaukee cars, are 19 ft. apart. On the Pullman cars they were 28 ft. apart, the Pullman underframe, however, being 1 ft. greater in total length. The side sills in the present case are 6 x 4 x 3/8 in., angles continuous for the full length of the underframe, while in the Pullman equipment 5 in. Z bars were employed. These side sills are tied to the center sills by two cast steel needle beams with a cast steel spacing block between the center sills as part of the structure, and by the pressed steel diaphragms arranged as is shown in the plan. The sectional illustration shows the construction and arrangement and the connections with the top and bottom 1/4 in. cover plates employed at the needle beams. It will be noticed that there is also a cast steel spacing block between the center sills at the center of the car which acts simply as a stiffener. On top of this underframe is secured 1/16 in. steel plates corrugated longitudinally, over which is secured seven light longitudinal nailing strips, the space between the strips being filled with hair felt and over this is laid No. 20 keystone corrugated iron flooring, which in turn is covered with 5/8 in. Flexolith flooring.

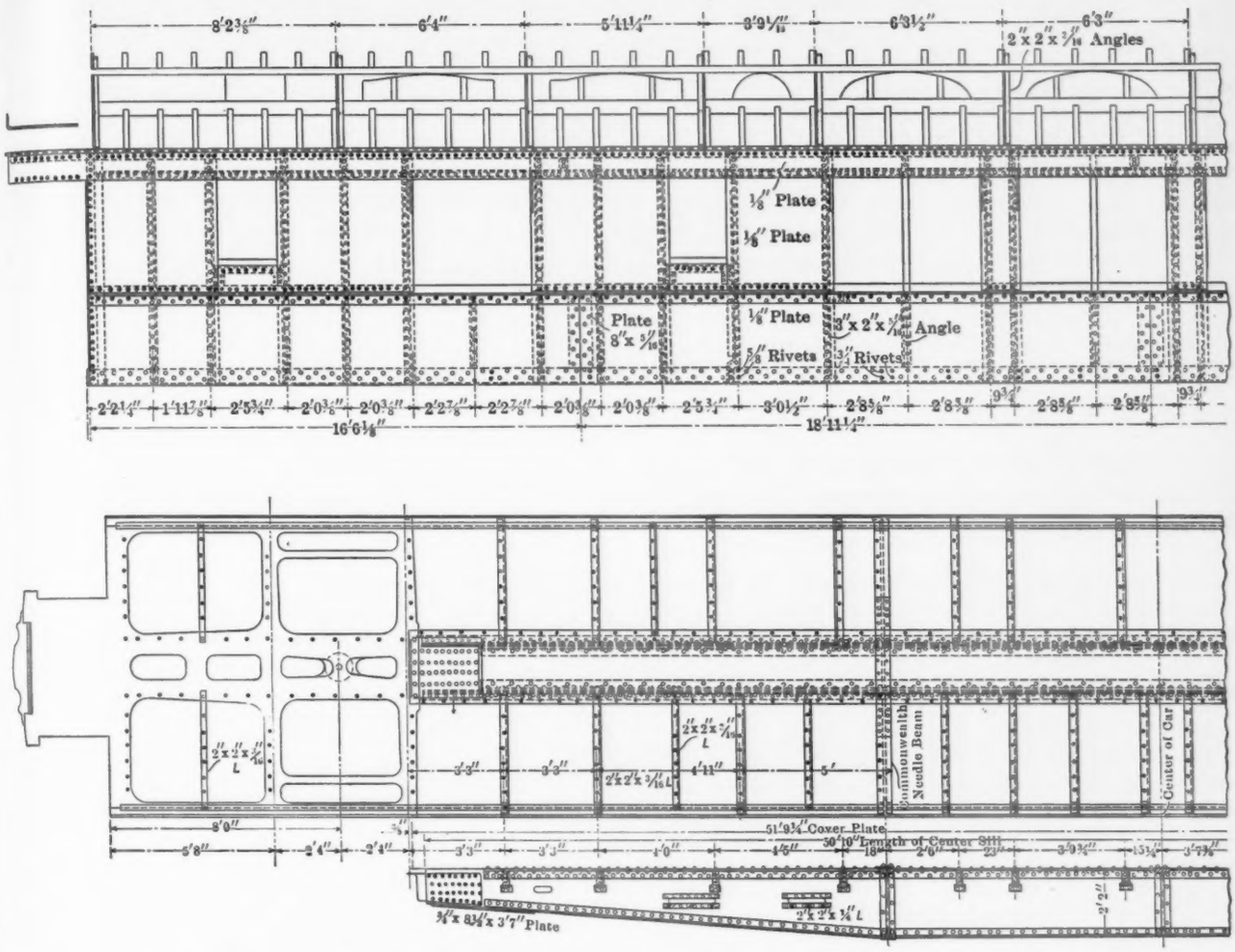
The steel framing of the superstructure is made up principally of standard sections, the side posts being 3 x 2 x 5/16 in. angles, being secured at the bottom, inside of the side sill angles and continuous without change of form to the plate which is formed by a 3 x 3 x 1/4 in. angle. The belt rail at the window sill is secured outside of the side posts and steel sheathing and consists of a 4 x 1 3/8 x 7/16 in. dropper bar.

Two forms of roof construction are employed, as required by the interior finish, one being a 2 x 2 x 3/16 in. angle carline pressed into proper form and continuous between plates, and the other being a carline extending from the plate to a 2 x 2 x 3/16 in. L forming the deck plate, to which the upper carlins are also secured, this arrangement giving the square clerestory effect where desired.

The lower deck is covered with No. 16 steel and the roof with No. 14 steel. The cross section of the car shows the arrangement and form of the wooden structure secured to the steel frame work, to which the interior finish is fastened and the photographs show the general appearance of the interior, well illustrating the most attractive inlaid decorations and use of art glass and attractive lighting fixtures.

Steel sheathing consisting of 1/8 in. plate is used on the sides of the car, the rivets being button headed, no attempt being made to simulate the appearance of a wooden coach. These plates are butt jointed with an 8 x 5/16 in. cover plate inside.

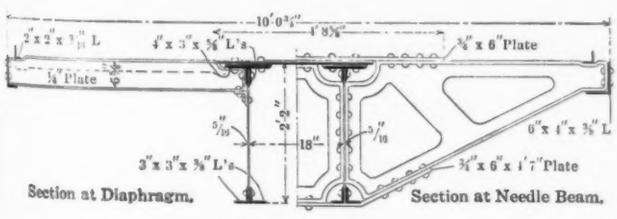
The end construction and vestibule arrangement offers no particular novelty. The body and corner posts are Z bars and the door posts, as well as the other two vertical members in the endframing are 4 in., 6 1/4 lb. channels, to which is secured the 1/8 in. steel end sheathing. The door and corner posts are set down into and are secured to the steel



STANDARD STEEL UNDERFRAME AND SIDE FRAMING OF MILWAUKEE STEEL PASSENGER EQUIPMENT.

casting to which the other posts are fastened by angles. The framing of the vestibule throughout is of steel.

In the interior arrangement of all of the cars the smoking rooms were installed on the right hand side to prevent passing



SECTIONS OF UNDERFRAME.

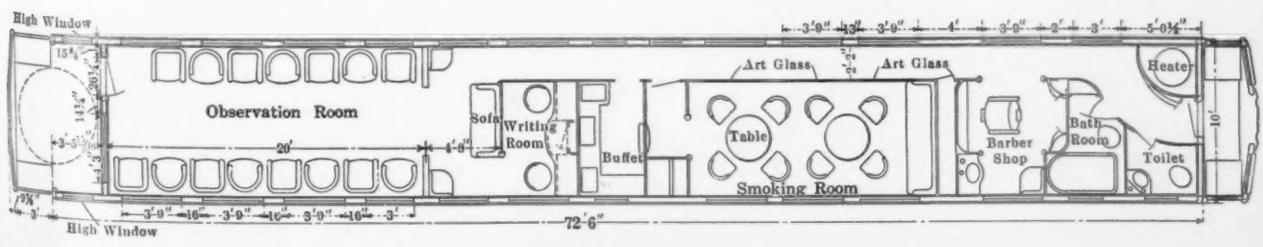
trains from obstructing the view. The typical plan of the buffet and observation car and the dining car are shown in the accompanying illustratons.

The cars are equipped with Chicago Car Heating Company's vapor system of steam heating and the electric lights are provided with current from a dynamo in the baggage car, according to the regular custom on the Milwaukee. Pintsch gas is installed and the sleepers and all heavier cars are equipped with a double set of Westinghouse brakes. Other equipment includes Chaffee centering device, Standard Coupler Co.'s type F buffing mechanism, Ohio couplers, Miner friction draw gear and Garland ventilators. The General Railway Supply Company furnished the Flexolith flooring and the steel trap doors.

These cars were divided between the Pullman Company, Barney & Smith Car Co., and the American Car & Foundry Co., the illustrations being those from the Pullman Company, the other builders, however, using practically the same construction.

The weights of the different classes are shown in the following table:

Baggage and mail	118,700 lbs.
Baggage cars	129,160 "
Coaches	135,000 "
Parlor cars	142,700 "
Dining cars	149,300 "
Tourist sleepers	148,000 "
10 section sleepers	156,200 "
12 section sleepers	152,300 "
Compartment sleepers	157,400 "

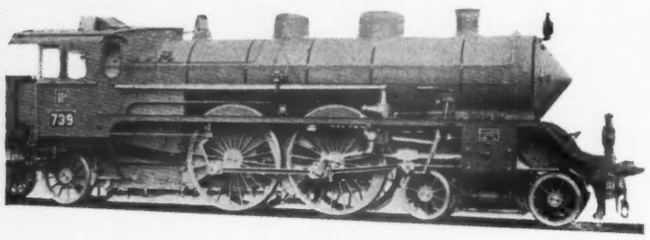


PLAN OF BUFFET-OBSERVATION CARS.

Practical Results of Wind Resistance Economies

W. R. McKeen, Jr., M. E., Member, Amer. Soc. Mech. Engrs.

If notice is taken of the changes in shapes of transportation mediums the world over, it cannot help but produce astonishment at the attention given and economies being obtained in this manner in all classes of vehicles. This has largely taken place within recent years since considerable useful data has been collected and published on the subject of wind resistance as applied to moving vehicles. The effect is particularly noticeable in some recent designs of locomotives and cars, electric high speed cars, and even on automobiles.



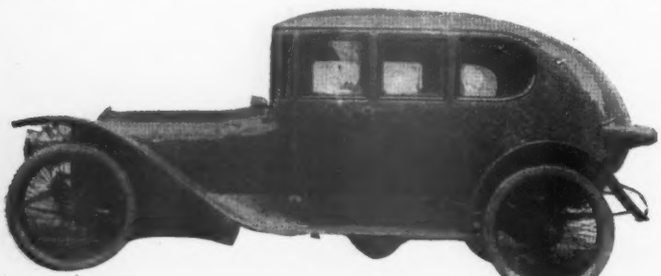
LOCOMOTIVE DESIGNED TO REDUCE THE EFFECT OF WIND RESISTANCE.

Illustrating what has already been done, the accompanying views of recent designs of locomotives built with pointed boilers and cabs, for railways in Austria and Germany, also pointed front ends and round rear ends of recent developments in meritorious automobile shapes, are striking. The reduction of resistance by the design of flying machines, sea-going vessels and motor boats is producing great practical and economical results, but in general it is in the construction of railroad and traction line equipment where the wind resistance is such a large factor, and where the greatest economies are obtainable, that the smallest advance has been made in securing these possible economies by reducing wind resistance.

The Berlin-Zossen high speed electric propulsion tests of 1902 were elaborately conducted and gave the engineering world some useful figures. The wind tests carried out by the Electrical Commission during the St. Louis Exposition, while differently conducted, were useful and verified the German tests, by showing the enormous amount of power necessary to force a blunt end car against the atmosphere at high and medium velocities.

In a test made by an English automobilist of a scientific turn of mind, he discovered that the addition of thirty square feet of wind resistance to his 38.4 horse-power Napier car reduced his maximum speed from 79 miles per hour to 47.85 miles per hour.

In order to determine with exactness what the practical value of the shape adopted for the body of its motor cars might be, the McKeen Motor Car Co. recently conducted a series of comparative tests with different arrangements and body designs, which very strikingly prove the importance of close attention to this feature in all railway vehicles. The tests were conducted under the supervision of the writer, the observations being made by Mr. A. H. Fetters, Mechanical Engineer of the Union Pacific. The test of each design (Figs. 1 and 2) was made on a round trip of 80 miles, between Lincoln and Beatrice, Nebraska, under similar weather conditions. By means of an anemometer, thermometer and barometer, frequent readings were recorded showing the wind velocity, temperature and pressures. The gasoline was measured by U. S. standard gallon measure. Each trip was made at the same average speed of 41 miles per hour, requiring one hour and fifty-seven minutes running time. The car and engine were in the same condition before, after and throughout the entire test, all conditions surrounding the test being very favorable in securing accurate data. Briefly summarized, the following results were obtained:



AUTOMOBILE BODY DESIGNED FOR HIGH SPEED.

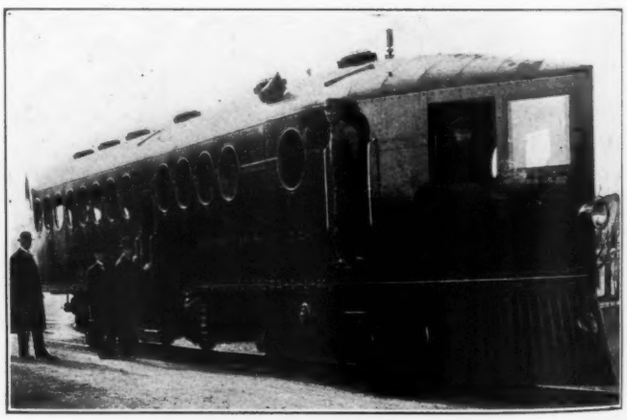
Performance with the wedge-shaped or pointed front end, 3.48 miles per gallon of gasoline.

Performance with blunt form of front end, 2.48 miles per gallon of gasoline.

Extra gasoline consumption due to the blunt form of front end, 40%.

It must be here noted that this extra 40 per cent. of gasoline was necessary to keep the car with the blunt front end up to the speed which the same car made the previous day under similar conditions, but with the pointed front end. This extra power required to operate the blunt end car was obtained with a wider throttle. Details of the test are shown in accompanying table.

The comparative drifting tests with the two forms of front end down a six-mile gradient averaging about ¾ of one per cent. are of especial interest. In both instances the speed of the car was 40 miles at the top of the hill, and it was allowed to drift freely. With the pointed front end the car drifted from Princeton to Hanlon, 6.5 miles, in nine minutes, the velocity of the car gradually increasing from 40 miles per hour at the top of the hill, to 50 miles per hour while descending the grade. With the blunt form of front end, starting at the top of the hill with the same speed of 40 miles per hour, thirteen minutes were required to cover the same distance, the speed of the car gradually *diminishing* instead of increasing, as did the car with the pointed front end, and it was necessary to clutch in the engine to carry the car over the last 1⅛ miles.

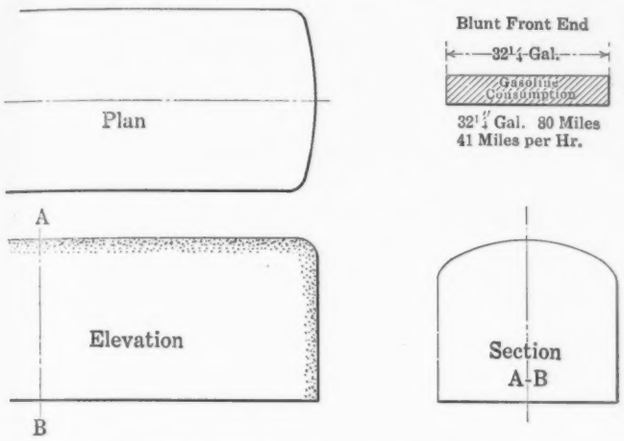


MCKEEN MOTOR CAR WITH WEDGE END.

The holding effect of the atmosphere on the blunt front end, and the effect on the speed of the car, was very noticeable during the drifting test. The efficiency of the car in climbing this hill on the return trip, as noted below, is also worthy of attention.

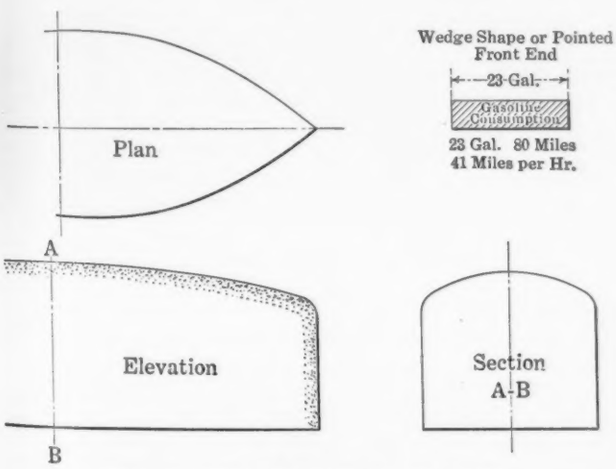
Distance	6.5 miles
Total rise	230 feet
Average grade	36 ft. per mile
Maximum grade	53 ft. per mile
Average speed of car, up-grade	45 miles per hr.

A very important observation of Mr. Fetters, while on this test, was the unsteady riding effect produced by the blunt front end. The importance of the wind resisting design of the McKeen motor car, which also produces easy riding qualities, is more fully appreciated in a similar design of the monorail car, in which equilibrium and high speed were the important factors considered. The atmosphere has the same effect on the pointed front end as it has on the projectile, and one of the noticeable features of the McKeen motor cars has always been their steady riding qualities at high velocity, due to the steadying effect of the wind on the wedge-shaped end. This condition



FORM OF BLUNT END USED IN THE TESTS.

disappeared when the blunt front end was applied, and it was observed that the car nosed about considerably. This fact is too important to lose sight of when comparing the relative merits of the two forms of cars, and it is secondary only to the economy in gasoline consumption shown by the pointed front end. It will thus be seen that the experiments conducted with this motor car demonstrated in dollars and cents the actual economical advantage to be gained by the use of a properly shaped vehicle. Not a small feature of this economy is the rounded rear end, which almost entirely does away with



FORM OF WEDGE END USED IN THE TESTS.

the vacuum produced by the ordinary square end cars. This not only produces a fixed economy, but almost entirely eliminates the dust nuisance.

With a single unit car it is much more important to consider head-end resistance, as some tests have shown that this head-end resistance is approximately 75 per cent. of the entire resistance, while with trains consisting of several cars, the side or surface friction necessarily gradually increases, according to the number of cars in the train, while the head-end area remains constant. It is thus seen that in long trains the proportion of head-end resistance is gradually reduced, but with a single unit car the head-end resistance, being so large a proportion of the entire resistance, is of prime consideration, and therefore anything that can be done to materially reduce the head-end resistance, especially on a single unit, self-propelled car, results in a direct and practical saving in the power necessary to drive the car at any speed above 15 miles per hour—this saving being proportionate as the speed increases, until, as shown at 41 miles per hour, a saving of 40 per cent. has been effected, by the proper attention to laws of resistance of a moving body through the atmosphere.

The effect of an opposing wind on a heavy, slow moving train is well known and comes in the same class with a fast moving vehicle in still air. Recently on a perfectly calm day a freight engine, with a 2,200-ton train load, covered a 152-mile district, water grade, register to register, in eight hours and thirty-five minutes. On a later date, with a strong, opposing wind, the same engine, with the same engine crew, pulling the same tonnage over the same district, required twenty-three hours and thirty-five minutes in which to make the run, and the engine consumed twice as much coal. The temperature was the same on the two days, the only difference in weather conditions being the strong wind on the latter trip.

In the following tables are given the detailed data of the tests referred to above:

BEATRICE TO LINCOLN.

Item.	Wedge Front End.	Blunt Front End.
Condition of weather	Clear	Clear
Condition of rails	Good	Good
Tempt. at beginning of run	43 deg.	47 deg.
Tempt. at end of run	58 deg.	53 deg.
Av. wind vel., ft. per min	3,950	4,809
Time leaving Beatrice	9:29 A. M.	9:16 A. M.
Time arrival Lincoln	10:29 A. M.	10:23 A. M.
Time on road	1 hr.	1 hr. 7 min.
Delays	2 min.	2 min.
Actual running time	58 min.	1 hr. 5 min.

LINCOLN TO BEATRICE.

Condition of weather	Clear	Clear
Condition of rails	Good	Good
Tempt. at beginning or run	60 deg.	64 deg.
Tempt. at end of run	64 deg.	72 deg.
Av. wind vel., ft. per min	5,448	3,800
Time leaving Lincoln	1:13 P. M.	1:31 P. M.
Time arrival Beatrice	2:12 P. M.	2:23. P. M.
Time on road	59 min.	52 min.
Delays	None	None
Actual running time	59 min.	52 min.

ROUND TRIP.

Actual running time	1 hr. 57 min.	1 hr. 57 min.
Av. wind vel., ft. per min	4,699	4,304
Amt. gasoline	23 gal.	32¼ gal.
Miles per gallon	3.48	2.48
Total mileage	80 miles	80 miles

SAFETY RECORD OF THE ILLINOIS CENTRAL.—According to a recent statement issued by the Illinois Central Railroad it has not killed a passenger in its suburban service in 55 years. By this is meant that no person has been killed, while being transported as a passenger, through the fault of the management. The statement also discloses the fact that during 1910 the company carried 30,728,211 passengers without a fatality over a system of lines that cover a territory reaching from the Gulf of Mexico to the Great Lakes and west as far as the Missouri River.

THE MASSACHUSETTS INSTITUTE OF TECHNOLOGY has published a bulletin in regard to instruction during the months of June, July and August, supplementing the work of the regular school year. The requirements for admission and in general the work performed and the final examinations correspond with those of the regular school year. The summer courses are open also to persons not students in the institute who possess the necessary qualifications.

PROGRESSING IN THE RIGHT DIRECTION.—Would it (scientific management) not hasten the Utopian condition which all right-minded men believe in and hope for; namely, that every man who is willing to work is entitled to a living and that no man is entitled to so much that somebody else must go hungry.—*David Van Alstyne before the Congress of Technology, Boston.*

DRIVING BOX LUBRICATION

W. J. SCHLACKS.

The fact that very material increased wear results from the use of other than the best lubricant is known to all who have used grease instead of oil for any length of time. The use of grease on these parts has very materially reduced the number of hot bearings, but a prominent railroad man asked me the other day if it were not a confession of weakness on the part of operating officials in adopting a fool-proof device of much less efficiency instead of insisting on the proper attention given a lubricating system of much greater efficiency.

It is not alone the increased wear of lubricated parts that is the price of this remedy for hot box troubles, but the increased coal consumption is proved by a test by Prof. Goss of Purdue University for the New York Central Lines, by the Pennsylvania test at the locomotive testing plant at St. Louis Exposition, and by road tests now being conducted. These laboratory tests were made on locomotives that were new out of the shop, and necessarily did not duplicate service conditions which must receive consideration to arrive at a conclusion that will be borne out in service. As an illustration: It is necessary when lubricating a driving journal from underneath to allow a certain amount of clearance between the sides of the brass and the journal (the amount depending on the nature of the lubricant) so that the lubricant can be carried up under the brass.

There is not so much clearance necessary with oil as with grease, and no clearance is necessary with oil lubrication through the top of the box; in fact, the brass can be fitted very close on the sides with just enough allowance made to avoid "pinching" when the box and brass warm up. This allowance can be reduced so as to be almost negligible with cellars accurately fitted to act as spreaders. In the tests referred to, the locomotives must needs be made suitable for grease lubrication so that they had more clearance than was necessary with oil from underneath, and a great deal more than is necessary with oil forced in through the top of the box. Whatever clearance was allowed made that much lost motion in the machine that had to be taken up by the movement of the piston, actuated by the steam, at a considerable reduction in actual working mean effective pressure before any actual work was done.

This extraordinary clearance invites a "pound" that more quickly increases the lost motion than is the case where the parts are fit snugly. And again, the engine with oil lubrication is sure to give just that much longer service as it takes to wear the difference in the original clearance allowed, plus the additional service that may be expected on account of the reduced wear of contact parts because of the better lubricant. Less wear on parts such as driving box and rod brasses makes less cylinder clearance necessary, which is a saving due consideration. Hub friction is reduced to a minimum on a testing plant, whereas the performance of the locomotive in road service is very much affected by the efficiency of the lubricant on these parts.

The pumping of the oil through the top of the box has in one case made possible the cool running of a new style locomotive, which was found impossible without it, on account of the even torque of the engine making it impossible to carry the lubricant to the point of working contact. In another case it had so increased the engine's efficiency that it made possible the hauling of ten passenger cars with the same facility that the locomotive with its driving journals lubricated with grease could haul nine cars. There are cases where this system of lubrication is used, where the reduction in coal consumption is commented on by the engineers and firemen that ride the engine, as well as the traveling engineers, and the road master mechanic.

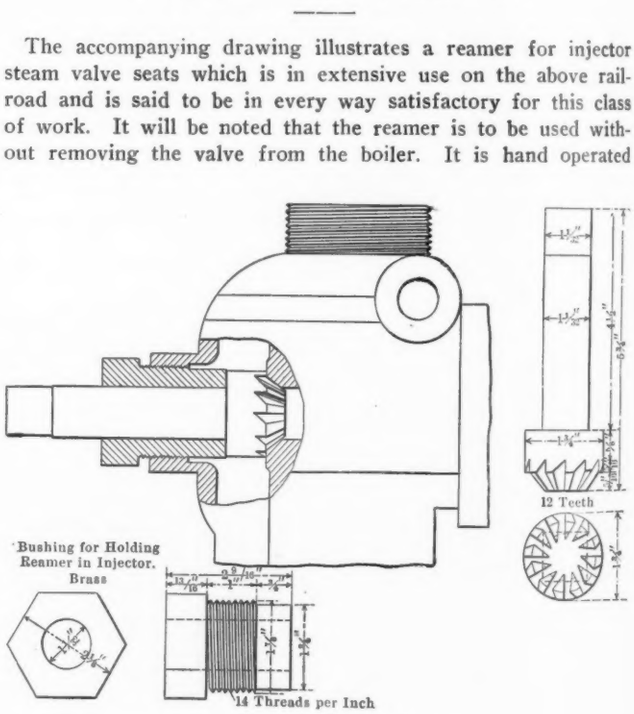
It is a fact that a locomotive driving box cannot be lubricated with grease when the oil hole is left in the top of the box, because the grease is forced out through these holes. I have instances in mind, where wooden plugs that were driven in the top of the box were forced out by the pressure exerted by the revolving journal, so that tapered brass plugs had to be driven from the inside.

The whole problem of most efficiently lubricating a machine is conveying to the parts needing it the best lubricants in the proper portions at the proper time. If, for instance, instead of allowing the oil to feed to the driving journals by gravity through the holes in the top of the box, as was the case in these tests, thus releasing whatever pressure the revolving journal generated and relying for lubrication on the little amount of oil that, due to its adhesiveness, could not be forced out through the top, the oil was forced in through the only opening in the top, and allowing the pressure generated against the oil to lift the box off the journal, entirely different results and of greater advantage to the oil would have been recorded.

REAMER FOR INJECTOR THROTTLE SEAT

CHICAGO AND NORTH WESTERN RY.

The accompanying drawing illustrates a reamer for injector steam valve seats which is in extensive use on the above railroad and is said to be in every way satisfactory for this class of work. It will be noted that the reamer is to be used without removing the valve from the boiler. It is hand operated



SPECIAL REAMER FOR INJECTOR THROTTLE SEATS.

and the requisite pressure is secured by tightening the large nut which encircles the shank of the reamer and serves as a guide.

The design of the cutter is such that the seat is always kept the original width, as it is cut down on top at the same time that the bevel is formed. The drawing clearly indicates the details of what will be found a useful addition to roundhouse equipment.

IN A SHORT HISTORICAL ARTICLE ON VANADIUM published in the columns of a contemporary, it is pointed out that its atomic weight is 51.27; specific gravity 5.5; melting point above 2,000 deg. Cent. It was vaguely known as early as 1801, but its actual discovery dates from 1830, when Sefstrom found it in Swedish iron. On account of its very high melting point pure vanadium cannot be added to steel; but ferro-vanadium, an alloy of one-third vanadium and two-thirds iron, fuses at a much lower point than either iron or steel, and may thus be dissolved and completely distributed through the molten bath.

Car Wheels and Axles---Boring, Turning and Mounting

A COMPREHENSIVE REVIEW OF THESE IMPORTANT OPERATIONS BASED ON CAREFUL STUDY, EXPERIMENTS AND TESTS, CONDUCTED WITH THE END IN VIEW TO SECURE IMPROVED DEVICES IN CONNECTION WITH A SAFE AND ECONOMICAL SYSTEM.

W. H. MARKLAND.*

For some reason not apparent the important operations of boring car wheels, turning axles and mounting wheels on axles do not seem to have been accorded heretofore the consideration and attention in railway shops which work of similar nature receives elsewhere, and with the object of introducing efficient and economical devices and methods a careful study has resulted in some conclusions which may be of general interest.

As the majority of axles and wheels machined in railway shops are for repair work, i. e., fitting new wheels to axles, or refinishing cut journals, this class of work will be particularly considered.

It is, of course, recognized that safety is of the utmost importance, and that wheels must be fitted to axles in such manner as to insure their not working loose in service. However, the question of cost of work of this nature is also a consideration. The fact that in no case has a wheel been reported loose when mounted by methods explained below, would indicate that the system is entirely safe, and, considered as a whole, more economical than most of the previous methods. In comparing cost of wheel and axle work, especially repair work, life of the axle should be carefully considered. Any method by which the useful life of an axle can be prolonged being true economy. As an illustration, the useful life of an axle is that between size when new and that when worn or turned to unsafe limits. For axles used on 100,000 pound capacity cars, the finish turned parts differ in size about ¼ in. when new and when ready for scrap.

If the metal of the axle be carelessly turned, its useful life is shortened. The ¼ inch difference in diameter between a new and a scrap axle which constitutes its useful life, may be compared to a tube with wall ⅛ in. thick. A calculation will show that this metal, considering new and scrap value of axle, is worth about 50 cents per pound, also that each .001 inch in diameter of this tube is worth about 4 cents. Or, put it another way: Suppose two identical axles are to be repaired. One is turned 1/32 inch smaller than the other on account of lack of care. The carelessly turned axle is reduced in value $1.28 more than the carefully turned axle. While the diameter may not be the cause of scrapping, the question of removing the smallest amount of metal possible in repairing is of the utmost importance, and from the above figures the question of a slight increase in cost of machining should be secondary to saving metal.

Dents or marks on journals often necessitate removing unnecessary metal for their elimination. Unless care is exercised when handling mounted wheels, there is a possibility of flange of one wheel striking a journal of adjacent axles, and also in handling axles with bars there is a possibility of dents and scratches. A very good preventive for mounted wheels and axles loaded on cars for shipment is, never load different sized wheels and axles adjacent to each other without blocking between. The same will apply when stored on tracks, this assuming that wheels and axles are placed close, so that one wheel will strike the adjacent axle inside the wheel. In this event the journals of ordinary car axles will not strike, and if reasonable care be exercised, there should be no necessity for placing guards on the journals. Where bars or chains are used for handling finished axles, many dents and scratches may be avoided by covering the bars or chains with old air brake hose. A dented journal should call for an investigation.

To properly machine axles and wheels several points are necessary to obtain the best results, and attention has been given to the following: the speed of turning centers in axles, lathe centers, turning tools, micrometer calipers, lathe centers in line, boring bars, etc. The question of proper make of lathes and boring mills will not be considered as being a question generally decided by each shop. With any fairly good lathe or mill the work can be well done, if tools are kept in good state of repair.

The importance of true, properly ground and fitting axle lathe centers cannot be overestimated; in fact, no lathe center in any shop should receive more attention, for the reason that axles during their life may be turned several times on different lathes, and, if the angle of centers is not uniform, the center in axle will be badly and unevenly worn and make it difficult to do good turning. A case came to hand where a few axles were turned some .010 inch out of round. Investigation showed that the lathe on which they were turned had centers of about 85 degrees angle, and that the axles were centered 60 degrees. As a result, the axle only bore on the lathe center at end or had a line bearing. This line bearing soon wore unevenly, allowing the axle to work back and forth, and this was responsible for the eccentricity of the axle.

Several of the modern axle lathes have only dead centers where grinding in place is not possible. Also in many cases they are too large for the average tool room grinder, and as a result the centers are not given the necessary attention. Recognizing the fact that where ready means are provided for grinding centers they will be kept in better order, the grinding machine, Figure 1, was designed. This machine will only grind to 60 degrees included angle, being made this way purposely to prevent possibility of being set wrong. It is not expensive, and would be a desirable addition to any shop. While savings cannot be put down in dollars, there is no question but that the resultant better work will justify its use. Center gauges are cheap, and should be frequently tried on centers, and in

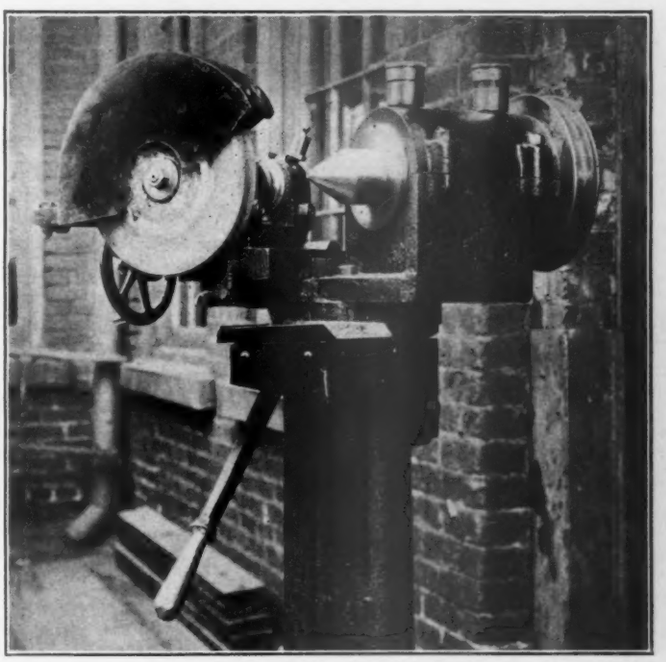


FIG. 1.—LATHE CENTER GRINDING MACHINE.

* Gen'l Shop Inspector, Pennsylvania R. R.

event of the latter not being to proper shape or rough, they should be repaired at once.

Another point brought out was the necessity of having lathes in proper alignment to insure turning a journal or wheel seat same diameter for its entire length. The importance of proper alignment can be appreciated when we consider that to mount a steel wheel having 7 in. hole, or cast iron wheel of same size, the axle should be .007 and .015 inches approximately larger than the wheel bore, and also each .001 inch variation will affect the mounting pressure some 10 per cent. If the wheel seat be turned tapered it is not possible to properly caliper except to average diameter, which will rarely be a true indication of mounting pressure. Also if turned tapered an extra strain may be exerted on one part of wheel with the possibility of no pressure on other parts. Actual cases have been noted where wheels have been removed that only had a bearing for part of their length owing to taper turned axles, and while the wheels did not come loose in service it is a condition which if known to exist would be bad for the peace of mind. By proper care in maintaining lathes the damage that may result from turning tapered can be avoided, and good turning that can only follow with lathes in good state of repair will result in a saving in labor when mounting the wheels on the axles. A very satisfactory test for lathe alignment is to take two or three light cuts for the entire length of the wheel seat and measure the diameter with micrometers. For wheel seats there should never be a difference in diameter exceeding .003 inch.

FIG. 2.—MICROMETER AXLE CALIPERS.

Tests made to determine the speed axle lathes should be run developed the fact that 45 r. p. m. was about the limit for car axles. The limit being the chattering of axle rather than cutting tool, as most any high speed steel will stand this speed with a stream of water flowing on the tool when taking light cuts, such as is generally necessary for repair work. The question of slow speed and coarse feed and fast speed and fine feed was also considered. For good work there is no question but that the fast speed and fine feed is the more desirable on account of avoiding large humps and hollows. A broad faced tool fed slowly may look satisfactory, but considering the fact that there is always a possibility of the workmen not setting the tool nose square, which is liable to result in the wheel only having a few points for bearing, and on the journal the burnishing wheel or other finish will have to push down or remove the high spots, the latter method is decidedly the better. In the writer's opinion the final cuts should never be taken with feed less than 16 pitch.

Proper inspection of axles is, of course, important, but to be of value and keep a shop up to proper standard, limits should be established. Inspection for diameters cannot well be made with machinists' calipers on account of being too slow, and embodying too much personal element. Without a question of doubt micrometer calipers are the more satisfactory for such work. At first glance this may appear a refinement, but experience has proven their value.

In order to reduce the time necessary to make micrometer caliper measurements, the calipers, Fig. 2, were designed by the writer, these having in addition to the ordinary micrometer an extra anvil set at right angles to the line through micrometer, which insures the caliper being at right angles with the object measured, and also stops which may be turned so that the distance from the stop to the center of the axle shall be approximately the radius of the latter. With the calipers illustrated, one set of stops is approximately correct for axles 6¾ to 7 inch, one set for axles 6¼ to 6½ inches. These stops can be made for any desired diameter within range of the micrometer screw. In service the caliper is placed over axle with the anvils and the stops resting on axle. It is then screwed down until the ratchet clicks, when it is removed and reading taken. This caliper obviates all "feeling" for measurement, such as is necessary with ordinary micrometers, and reduces the possibility of error. In practice six measurements can readily be made, and results read in one minute. By use of the caliper in question an exact reading to .001 inch can be made and recorded very much quicker than by machinist's calipers, the latter being only of value in mounting wheels when compared or adjusted to calipers previously set to some particular wheel bore.

A method of inspection that has worked out very well in practice has been as follows: Each wheel seat was calipered about 1 inch from dust guard seat, at middle, and about 1 inch from end nearer center. These readings to agree within limit of .003 inch, the average size being chalked on the axle for information when mounting wheels. Should these readings vary over .003 inch, the axle is sent back for returning. The journal to be inspected in a similar manner, but without recording sizes. No particular trouble can result from the two ends of axles not being similar, and any attempt to make them alike would result, in many cases, in removing unnecessary metal. By boring wheels to suit axles, as will be explained later, the workmen on the lathes do not have use for calipers except for maximum or minimum sizes, which is somewhat novel for lathe work.

The question of turning all new axles to one exact size and returning repaired axles to snap gauges varying by 1/16 in. or 1/32 in. was carefully considered. A large number of axles which were calipered that had been turned apparently to uniform sizes showed quite a variation when measured by micrometers, in some cases as much as .010 inch. This would be too great for mounting in wheels all bored to one size. Better

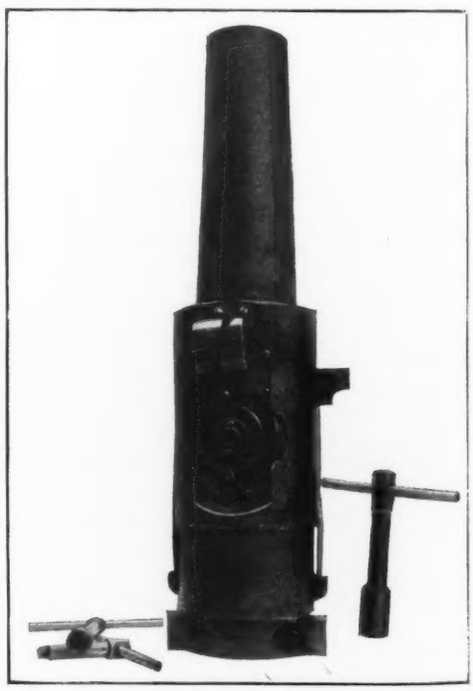


FIG. 3.—NEW DESIGN WHEEL BORING BAR.

work than this is, of course, possible, but is also expensive. Investigation brought out the fact that with proper boring bars wheels may be bored to varying sizes to suit axles cheaper than axles can be turned to suit the wheels. To accomplish this called for a boring bar that should be readily adjustable to varying sizes to suit different axles. These should have micrometer adjustment and index plate that shall readily indicate size of bore in thousandths of an inch, be quick to change from one size to another, adjustment to compensate for wear of cutties in order to obviate necessity of grinding them to very close measurements. Roughing cutters for first cut and finish cutters for finish or second cut, and all in one boring tool.

This refinement called for a design of boring bar new in some respects for wheel work. Figure 3 shows a bar that was designed by the writer to meet the above requirement. Other bars have been modified or designed of late, so that with proper selection there should be no difficulty in obtaining a satisfactory boring bar. A brief description of bar, Figure 3, may help to illustrate the points necessary for a satisfactory boring tool. The roughing cutters at the lower end are held by set screws and are only adjustable by loosening these screws. This is very satisfactory for large shops boring many wheels to near one size. However, for small shops where sizes are changed often, more ready means for adjustment is desirable. The finish cutters shown above the roughing cutters are adjusted as to size by a wrench turning a micrometer screw. On the micrometer screw there is a dial graduated into 100 divisions, each division equalling .001 inch in diameter of finish cutters. This number of divisions being chosen on account of allowing large spaces between divisions which may be easily read.

In case an adjustment over .100 inch is required, the micrometer screw is turned more than one turn. The index plate is held to the micrometer screw by two screws. By loosening these it can readily be revolved in reference to micrometer screw. This enables setting the index plate to indicate the size of bore, and to compensate for the wear of cutters. The finish cutters also have adjustment by which they may be adjusted true with the bore in wheel, this being desirable to avoid too close grinding of cutters, and also on account of ram of boring mill and table not always being in line. The finish cutters may be ground, one fully 1/16 in. longer than its mate or the bar may be 1/16 in. out of line and be compensated for in adjustment.

A few words about first-class wheel boring may not be out of place. Without a doubt, wheels should be bored having a true hole free from all ridges or roughness. Ridges in wheels are very objectionable on account of uneven strains on the wheel when mounting, making a leverage that may start a crack. On account of the eccentricity of the rough bore of steel wheels, and the core of cast iron wheels, there will always be some motion of the boring bar when boring, even with the most rigid construction. That is, the bar will follow the hole, also when the roughing cutters start to go out at the bottom of the hole the bar will vibrate less than when cutting higher up in the hole, which is apt to leave a ridge in the bore. If finish cutters are in use at the same time, they will make a ridge when roughing cutters are through the hole. The safe way to bore a wheel is to take a light finish cut independent of roughing cutters. This is a point well understood in machine work, but, strange to say, for wheel work the scheme of rough and finish boring all at one time is advocated, principally on account of greater output of machines, and while it is true that many wheels are bored very satisfactory by this plan, the method as a whole is undesirable, on account of stray wheels going into service having ridges in the bore. Actual trials on cast iron wheels showed that after rough boring it was necessary to enlarge the bore .040 inch to insure trueing the bore of all wheels.

To bore wheels to close sizes it is desirable to allow a predetermined amount of work for finish cut. This is to insure an equal amount of work for the cutters, and also uniform pressure on the various parts that will naturally have more or less give or lost motion. For cast iron wheels the finish cut can, with safety, be set at .040 inch, and for steel wheels about .020 inch. A practice followed with most excellent results with the bar, Figure 3, has been to set the roughing cutters to the smallest size bore required in ordinary limits; for instance when boring wheels 6⅞ in. to 7 in. they would be set 6⅞ in. As each wheel was rough bored the finish cutters were set .040 in. less than the size required, and the wheel was then bored with both sets of cutters in operation at one time. After this cut was completed, the bar being raised, the finish cutters were set out to the required size and the second cut taken when the finish cutters only were cutting. As an illustration of accuracy that may be attained, wheels were called for bored to following diameters: 6.982, 6.842, 6.928, 6.922, 6.940, 6.848, 6.809, 6.810, 6.822, 6.796 inches. All the wheels were bored in the order called for within a limit of .001 inch. No caliper readings were taken except to prove sizes after the wheels were removed from the mill. All changes in sizes were accomplished by turning the index wheel to the size called for, and the boring was done as fast as the cutting tools would permit. With a satisfactory boring bar having an acurate micrometer adjustment for finish cutters, wheels can be bored to any size required to accuracy of .001 in., and as many wheels turned out as by any method.

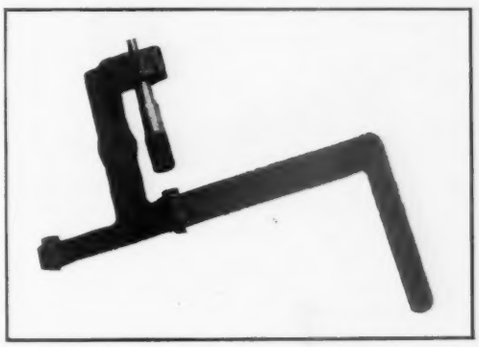


FIG. 4.—MICROMETER WHEEL BORE CALIPERS.

On account of this accurate wheel boring, which is an accomplished fact, it certainly is advisable to bore wheels to suit the axles on account of less cost for labor, and only turning the smallest possible amount from axles.

A satisfactory manner of setting finish cutters is as follows: A trial cut to be taken and calipered with micrometer calipers; the index can then be set to size shown by micrometer readings. Figure 4 illustrates a special micrometer caliper that was designed by the writer for wheel bore. The principal novelty is in the extra anvil to insure the caliper being set square with center line of wheel. Figure 5 shows an application of tubular inside micrometer caliper for same purpose. By either of these caliper readings may readily be made and size chalked on the wheel in 30 seconds.

The question of mating wheels to axles to obtain proper mounting pressure has always been and will continue to be a problem. Many theories were investigated where they appeared to have bearing on the subject. One of the old theories being that the hardness of wheel had everything to do with mounting pressure. There may have been some truth in this, but the writer was unable to discover it from advice of men several years in the business. Several trials were made with the workman's judgment of hard and soft wheels where it was claimed that the hardness would govern mounting pressure, also the draw or difference in axle and wheel diameter was carefully measured, and in no case could the general appearance of the wheel be taken as an indication of mounting pressure. Or, in other words, wheels made from the same run of metal will generally mount at about the same pressure when having the same draw, providing other conditions are similar. There are a number of conditions that will affect mounting pressure, even if apparent draw be similar. One is the kind of lubricant employed. A test with cast iron wheels showed that the mounting pressure would average about five tons higher using plain oil as compared with white lead and oil. Also the turning and calipering of axle has some bearing. If a tool is used that throws up a slight burr or fin, the calipers will read the top of this and not

the true solid metal which is liable to cause mounting at low pressure. The trouble of wheel or axle galling cannot in all cases be guarded against and may cause considerable variation in pressure, especially on steel wheels.

For accurate mounting of wheels to uniform pressure, no method of measurements and inspection has been devised to equal the micrometer method, and, with the calipers as explained above where the readings can be made quickly with but few possibilities of error, there should be no reason to continue the use of machinists' calipers.

One result will generally follow where micrometers are used, and careful inspection is insisted on. The wheel seat will be turned fairly true. With these conditions and draw, or mounting pressure, carefully checked, the wheel will have ample bearing on axle and will not work loose. A large number of measurements were taken to determine the proper draw or amount the axle should be larger than wheel. No general rule can be given for the amount of draw on account of wheel from various mills and foundries differing. However, by measuring the draw with micrometer and noting mounting pressure on a few wheels, the proper draw for any batch of wheels can be arrived at that will be a fairly true indication of mounting pressure.

A plan for mounting wheels on axles that has worked very satisfactory is as follows: Each axle when turned is calipered and the size of wheel seat chalked on the axle near wheel seat. From these sizes a list is made for the boring mill operator, deducting the necessary amount to be allowed for draw. The wheels are then bored and size chalked on the wheel after being proven by micrometers. The wheels and axles are then mounted, the sizes chalked giving necessary information as to which should go together. This plan avoids hunting among a lot of wheels and axles to find mated pairs and also the minimum amount of calipering.

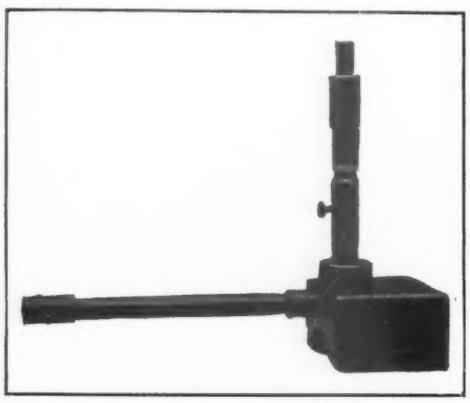


FIG. 5.—TUBULAR INSIDE MICROMETER.

The micrometers illustrated above have Brown & Sharpe micrometer heads, the frame having been made special on the railway where they are used, and to the best of the writer's knowledge have never been patented. The tubular inside micrometer caliper, Figure 5, was also made by Brown & Sharpe.

Recording gauges on mounting presses cannot be too strongly recommended, they being a check by which the superintendent can easily detect any bad or careless work. However, a recording gauge is not always a true indication of mounting pressure on account of the throw of the needle at each impulse of the pump. This is more noticeable with pumps having only one ram or piston. For accurate work or determined limits the average of the needle throw should be mostly considered.

The question of grinding in place of turning repaired axles is worthy of careful consideration. At first glance it may not look inviting on account of the apparent cost of machinery and possibility of costing more for labor than turning, but considering other phases, the question looks promising. Its advantages will be that a wheel seat once ground will not be injured enough in mounting and dismounting the wheel to require regrinding each time unless the wheel galls or scores the axle. That is, when compared to turning, the surface will be smoother and not have the many tool marks that generally push off when mounting the wheel. From experience with journals used in machinery we have every reason to believe that car journals would be ground better than the average of lathe turning and burnishing or filing. The sides of the collars and fillets being the most difficult parts. The makers of grinding machinery, however, say this is not a hard problem. By grinding the probabilities are that less metal will be cut away than by any turning method on repaired axles.

This should prolong their life. That is, when returning there is always a possibility of workmen cutting deeper than absolutely necessary in order to get below the glazed surface and insure removal of all low spots. With grinding there will be no incentive to cut deeper than absolutely necessary. Actual tests appear to indicate that by grinding only one-half as much metal will be removed as compared to turning; that is, where an axle may be reduced some .030 inch by turning, a similar axle will only be reduced some .015 inch by grinding and, as explained above, each .001 diameter costs about four cents, at which rate the value of axle would be reduced about 60 cents more by re-turning when compared with grinding.

INCREASED USE OF BLOCK SIGNALS

The Interstate Commerce Commission has issued a brief statement regarding the use of block signals on the railroads of the United States, on January 1, 1911, from which it appears that the total miles of railroad operated under the block system on that date was 71,269.1 miles, of which 17,711.5 miles was automatic and 53,557.6 was non-automatic. The increase in railroad mileage operated under the block system during the year 1910 was 5,511.1 miles; of this increase, 3,473.8 miles was automatic and 2,037.3 miles was non-automatic.

This bulletin includes thirteen steam roads which have not heretofore reported the use of the block system on their lines, and six electric trolley roads which were not included in the bulletins of previous years. In this bulletin four installations of automatic train stops are mentioned. These are on the Erie, the Hudson and Manhattan, the New York City terminal of the Pennsylvania Railroad, and the Washington Water Power Company's suburban lines.

A table showing the miles of road for each company reporting on which the telegraph and the telephone are used for transmission of train orders is also included in this bulletin. On January 1, 1911, the telegraph was used for this purpose on 175,211 miles and the telephone was used on 41,717 miles. This is an increase of 15,373 miles, on which the telephone was used, as compared with the figures for January 1, 1910.

THE LARGEST CRANE IN THE WORLD.—The largest cantilever crane which has yet been erected has just been tested at the Imperial Japanese Navy Dockyard, Yokosuka. This crane, which was designed and constructed by Messrs. Cowans, Sheldon & Co., Limited, of Carlisle, is capable of dealing with a working load of 200 tons at a radius of 95 ft., and it was satisfactorily tested with a load of 250 tons at that radius. It is the largest crane that has up till now been built, but the same firm is at present erecting for the Japanese Navy, at Kure, one with a working power of 200 tons at 105 ft. radius, to be tested with a load of 250 tons. Hitherto the largest crane in existence has been the 160-ton cantilever crane, constructed by Messrs. Cowans, Sheldon & Co. for H. M. Dockyard, Devonport, and tested with a load of 240 tons at 95 ft. radius; that power being much greater than was obtainable by any crane previously built.

THE STATISTICS PREPARED by the American Iron and Steel Association show that the total rail production of all kinds in the United States in 1910 amounted to 3,634,029 tons, as compared with 3,023,845 tons in 1909.

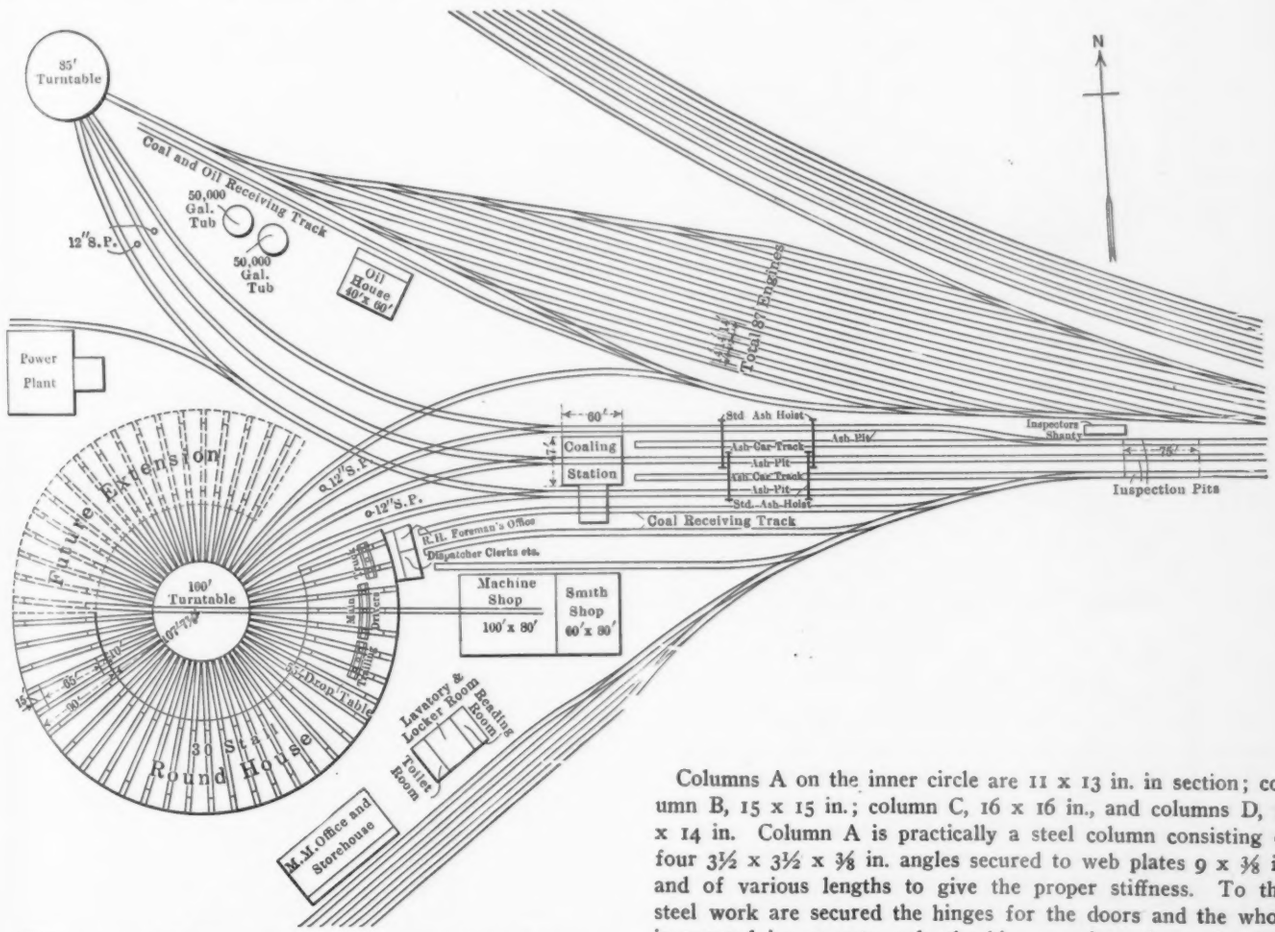
Orangeville Locomotive Terminal.

PENNSYLVANIA RAILROAD.

A new locomotive terminal constructed by the Pennsylvania Railroad at Orangeville, near Baltimore, Md., which will take care of the power previously centered at Mt. Vernon, Biddle Street and Bay View, is notable for the very high character of the structures and the convenience of its arrangement. It includes a 30-stall reinforced concrete roundhouse, a large brick and steel machine and blacksmith shop, a commodious store house, fireproof oil house, a large power plant housed in a very attractive structure and a conveniently located, well arranged engineers' locker and reading room, as well as the usual coaling station, inspection pits, etc.

Referring to the illustration showing the general arrangement: The incoming locomotives enter from the left on a single track (not shown on the drawing), which separates into three incoming tracks before reacing the inspection pits. There is a 75-ft. inspection pit on each track, adjoined by an inspector's shanty, where the engineers' work reports are made out. These three tracks continue over the ash pits, which are the standard Pennsylvania type using an air hoist,* and under the coaling station, where the supply of sand is also obtained. At this point each track divides, permitting the locomotives either to go to the roundhouse turntable, if they are to be taken into the house, or to an 85-ft. turntable in the northwest corner of the property, which connects with the storage yard. There are standpipes for water supply serving all of these tracks. A single outgoing track leaves the roundhouse turntable and connects directly to a ladder forming the outgoing connection from all of the storage tracks. This track is served by a standpipe at the far end of the yard, but does not permit of taking coal or cleaning fires on the way out.

The illustration shows the general inter-relation of the building, and while at first it might seem that the oil house was not in a very convenient place, when it is remembered that many more locomotives pass though the storage yard than go to the roundhouse, it will be seen that this structure should be more convenient to that part of the terminal.



GENERAL ARRANGEMENT OF NEW LOCOMOTIVE TERMINAL AT ORANGEVILLE—PENNSYLVANIA RAILROAD.

* For detailed description see AMERICAN ENGINEER, Feb., 1906, page 47.

ROUNDHOUSE.

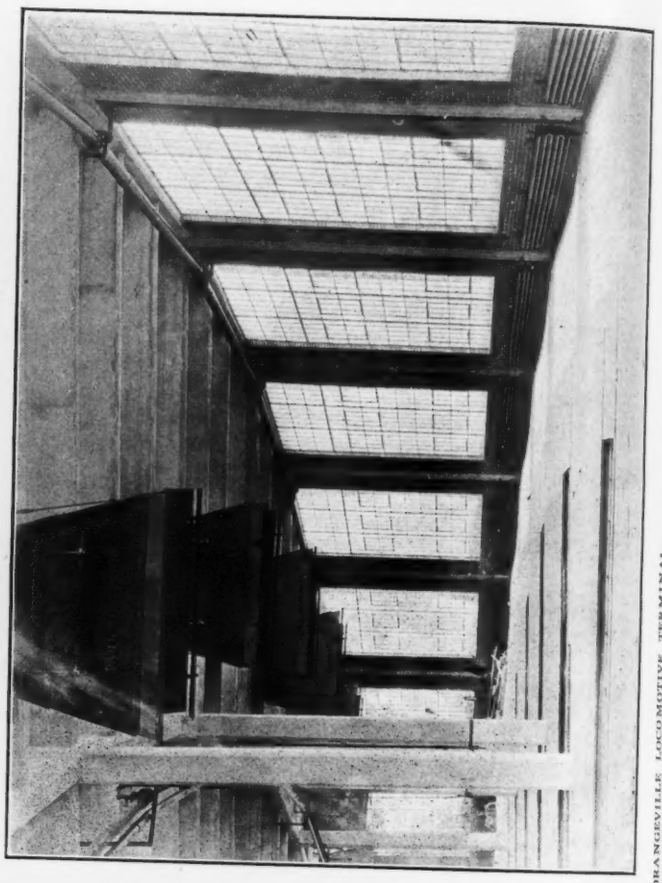
Structure.—This building has a solid reinforced concrete frame, each segment consisting of four columns, connected by girders, beams and slabs on the monolithic order.

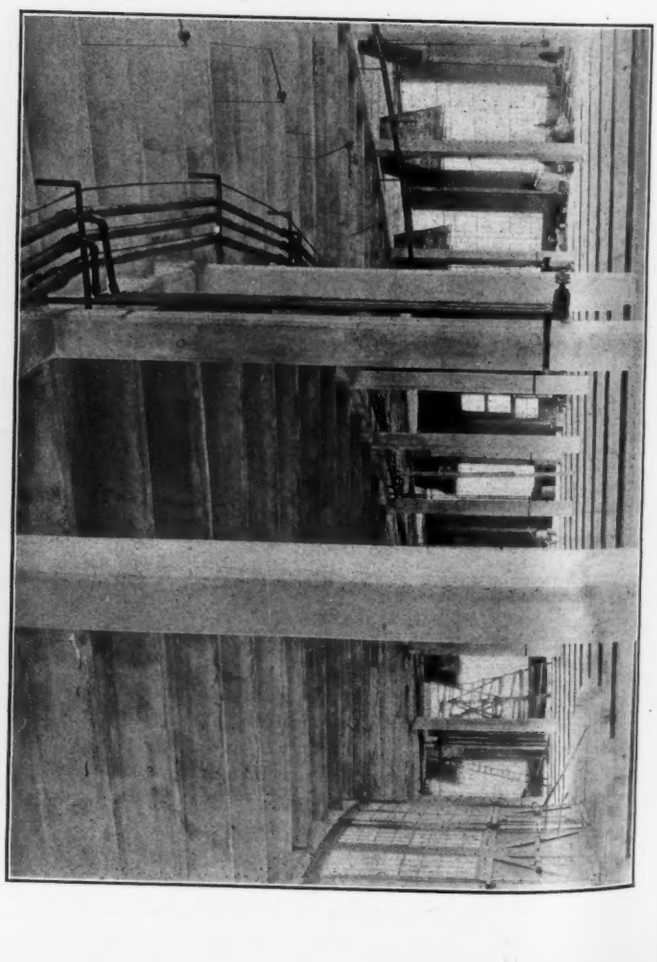
Columns A on the inner circle are 11 x 13 in. in section; column B, 15 x 15 in.; column C, 16 x 16 in., and columns D, 14 x 14 in. Column A is practically a steel column consisting of four 3½ x 3½ x ⅜ in. angles secured to web plates 9 x ⅜ in. and of various lengths to give the proper stiffness. To this steel work are secured the hinges for the doors and the whole is encased in concrete, only the hinges and conductor brackets projecting through.

Between columns A is girder A reinforced on the bottom by two 6-in., 8-lb. channels riveted to the steel work of the columns. In addition there are other horizontal and vertical reinforcing rods to suitably form the eaves and gutter and to tie to the beams.

Columns B are reinforced by four ⅞-in. plain round rods, which are tied every 12 in. with ¼-in. wire ties. Columns B are connected at the top by girder B, which has a total depth of 2 ft. 10 in. and a width of 12 in., being reinforced on the bottom by five 1-in. square twisted rods, 3 being straight and 2 bent up at the ends.

Between girder A and girder B there are three beams, two coming at the posts and one in the center, which have a total





GENERAL INTERIOR AND EXTERIOR VIEWS OF ORANGEVILLE LOCOMOTIVE TERMINAL.

depth of 2 ft. 4 in. and a width of 9 in. These are reinforced by three 1¼-in. square twisted rods, two straight and one bent up at the ends, together with the stirrups of ⅜-in. round iron.

Columns C are connected by girder C, which is the same as girder B in section, but has five 1¼-in. square twisted rods for reinforcing. Between girders C and B there are four beams, two at the posts and two spaced midway between, having a section the same as between A and B, but having four 1-in. square twisted rods, two of which are bent up at the ends, in place of three 1¼-in. rods.

Between columns D is girder D, which is 2 ft. 10 in. in depth and 12 in. in width and is reinforced with four 1-in. square twisted rods, two bent up at the ends and other reinforcing to form the eaves and gutter. Between girders C and D the same beams as between B and C are continued.

It will be noticed that the span between girders C and D is shorter than between C and B, which in turn is shorter than between A and B, which accounts for the use of similar concrete beams, although the roof area supported continuously increases.

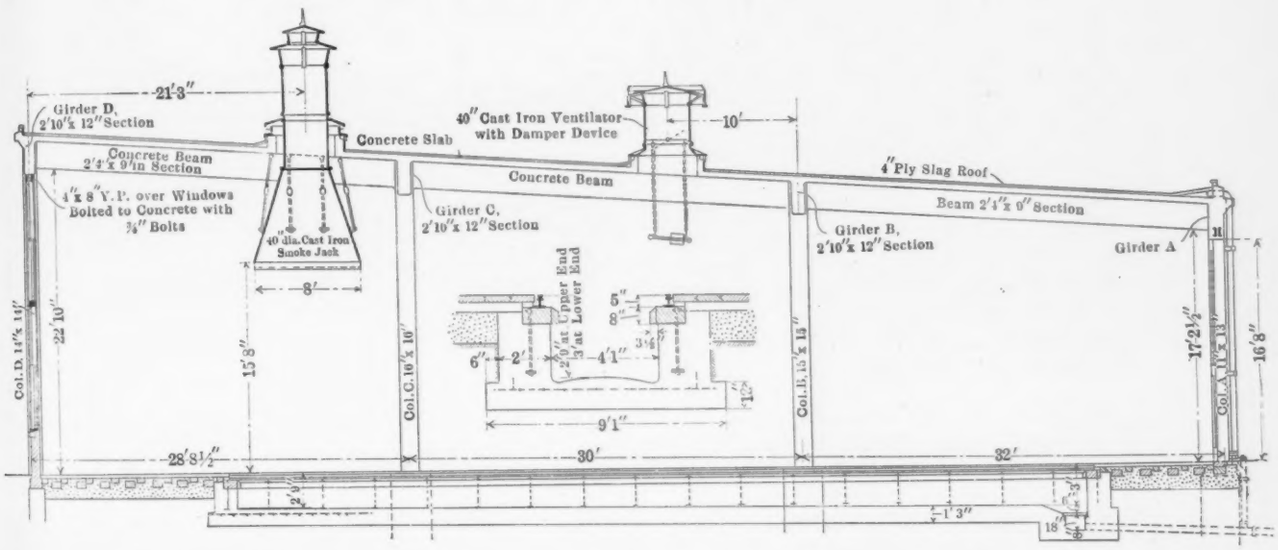
The roof structure is concrete slabs 4½ in. thick reinforced by ⅜-in. plain round rods spaced 6-in. centers across the beams and by ⅜-in. shrinkage rods at about 18-in. centers parallel with the beams. Other reinforcing is installed at the connection with the various girders and beams. These slabs are covered with four-ply slag roofing. The openings for the smoke jacks and ventilators are formed in the slabs and eyebolts for carrying the jacks are embedded in the concrete.

The outer wall of the house is formed by a 9-inch brick filling between columns D and below girder D. This filling is not tied to the concrete work and extends to foundation at the ground level. A large part of the space, however, is taken up by window area, steel frames and sash being employed, which extend from the concrete girder to about 3 ft. 6 in. from the ground level where blue stone sills, resting on the brickwork, are located. These windows occupy a space 16 ft. 9½ in. in width, the distance between centers of columns being 23 ft. 11 7/16 in.

The floor consists of 3 x 12-in. plank laid radially, parallel with the pits, on 4 x 6-in. pine sleepers imbedded in 18 in. of cinders. The floor at the center between pits is 4 in. higher than the rail. The doors are of the usual swinging type and are arranged to swing inward. They are carried from hinges imbedded in the concrete columns and give an opening of about 12 ft. Every third pit is provided with a wicket door. The end walls are of brick filling between concrete columns and provided with narrow windows in each panel.

Pits.—The pits are of most substantial solid concrete construction, reinforcing rods being used wherever the character of the ground made it necessary. The side walls throughout are 2 ft. in width and the foundation is at least 12 in. thick at the narrowest point and is 9 ft. 1 in. in width, except at the jacking walls, where the width of the side walls is carried out to 3 ft. 6 in. and the width of the foundation to 12 ft. 1 in. These extensions for jack foundations are 8 ft. in length and located at the outer end of each pit on either side and at a point 27 ft. from the outer end of the pit. The bottom of the pit is well crowned and has a slope of 3 in. in its length of 65 ft. inside, draining toward the inner circle. Here there is a cast iron grating over a sump, which connects with a 4-in. cast iron pipe leading to the turntable pit. The rails are carried on 8 x 12-in. stringers bolted to the top of the concrete wall, as is shown in the cross section. A 3 x 8-in. oak strip with the upper edge beveled is spiked inside of the stringer, acting as a protection for the heating pipes, which are secured along the inside wall of the pits. The roundhouse floor is carried directly up to the rail on either side.

Eight pits in the end of the house adjacent to the machine shop are provided with drop pits. The first two tracks having a drop pit for truck wheels, the next three a drop pit for drivers and the following two a drop pit for trailing wheels. The next pit is provided with a 55-ft. drop table for dropping all wheels on the locomotive at once.* These drop pits are built with the same general style of walls and floor as are used in the regular engine pits.



SECTION OF REINFORCED CONCRETE ROUNDHOUSE ERECTED BY THE PENNSYLVANIA RAILROAD AT ORANGEVILLE.

Cast iron smoke jacks, of a new design recently developed by Paul Dickinson, Inc., are used. These jacks have a length of 8 ft. and are supported from the I-bolts imbedded in the concrete roof slabs. The hood of the jack joins a 40-in. diameter circular section made in two parts, which passes through an opening 4 ft. 6 in. square in the roof slab, provided with a heavy 8-in. concrete curb for distributing the stresses to the adjacent beams. The space between the jack and the roof is covered, but not closed, with a cast iron extension forming part of the jack, space being left for ventilation at this point. The top of the jack has a double hood for protection from rain or snow. In addition to the space around the smoke jacks for ventilation there is also provided a ventilator at about the center over each pit. These ventilators have dampers controlled by a sliding weight on the end of a chain operating gear. Their construction and arrangement is shown in one of the illustrations.

Lighting.—Inasmuch as this type of house is not provided with any overhead natural lighting, as has been customary in most new houses, special attention was given to providing large natural lighting area at both ends of the pit, and in this respect, as is clearly shown in the illustrations, unusual success has been obtained. The windows in the outer circle are about

* For illustrated description of this type of table see AMERICAN ENGINEER, March, 1906, page 84.

GENERAL INTERIOR AND EXTERIOR VIEWS OF ORANGEVILLE LOCOMOTIVE TERMINAL.

16 ft. 9½ in. in width and 18 ft. 10 in. high over the frames; a steel sash known as Detroit Fenestra, manufactured by the Detroit Steel Products Co., is used. For large areas of this kind this type of sash has many advantages, not only in its strength, but also in greatly increasing the available lighting area. In each of the large windows there are six sections arranged to swing on the horizontal axis and provided with controlling rods for holding in any desired position. On the inner circle the swinging doors have large sash in each. This gives altogether about 375 sq. ft. of natural lighting area per pit, not including the windows in the end wall.

The heating system is by direct radiation and includes four large pipes running the full length on either side of each pit and a coil consisting of six sections extending the full length between concrete columns under the windows in the outer circle. This heating system was designed and installed by the National Boiler Washing Co., who also furnished the boiler washing equipment.* The three pipes used in the boiler washing and filling system are supported by brackets secured to the concrete beams along the inside of column B, the connections coming down at every alternate post, arranged as is shown in one of the illustrations. Similar brackets carry the high pressure steam and air lines along the top of column C, while the same supply for the heating system is carried in a large pipe at the top of columns D. The exhaust lines for the heating system are carried in a conduit just inside the foundation of the outer circle, this being covered with removable sections of flooring.

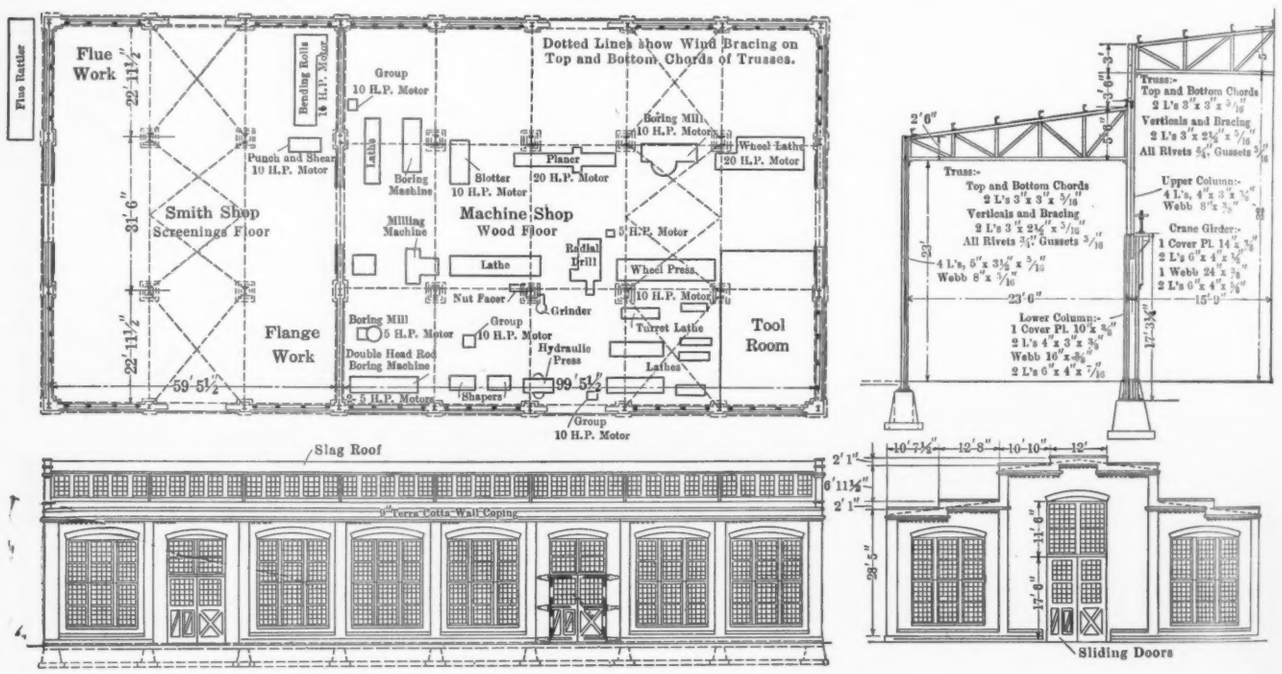
The boiler washing tanks and pumps and other apparatus are located in the power house and pipes are carried to the roundhouse in an elevated wooden trough supported by steel bents. This same elevated conduit also carries the steam heating lines and other pipe lines from the power house.

Turntable.—The turntable pit has concrete side walls and a concrete ledge for supporting the circular rail and is floored with brick paving. The table is a 100-ft. standard Pennsylvania type and is propelled by the standard electric turntable tractor of George B. Nichols & Bro., which operates the turntable with the heaviest locomotive at a rate of 60 degs. in 60 seconds. This tractor is simply an attachment to the table and is entirely self-contained. It is driven by a 22-h.p., three-phase, 220-volt motor. The cab is on the tractor frame and all controlling appliances are located therein. A similar tractor is used on the 85-ft. turntable at the end of the storage yard. Since this latter turntable is located on the property line and has entering tracks from but one side, the concrete circular wall has been carried up about 3 ft. above the surface on the far side to act as a bumping post and prevent the locomotives running off the end of the table.

* For full description of this washout system see AMERICAN ENGINEER, Dec., 1910, page 469.

SHOP BUILDING.

A steel and brick structure 80 ft. 3 in. x 162 ft. 10 in. outside dimensions, houses the machine and blacksmith shop, the two shops being separated by a brick wall. This structure consists of three bays, the center one being carried up to give a row of windows on either side. There is a 10-ton crane over the center bay of the machine shop. The structural details and architectural appearance are clearly shown in the illustration, as



MACHINE AND BLACKSMITH SHOP AT ORANGEVILLE.

are also the arrangement and list of machine tool equipment. The same careful attention to natural lighting found in the roundhouse is also apparent here. The side windows have wooden sash and are balanced one with the other, while the windows in the clere-story are provided with an operating gear, so they can be controlled from the floor level. The total natural lighting area of the building in square feet is almost exactly equal to the floor area.

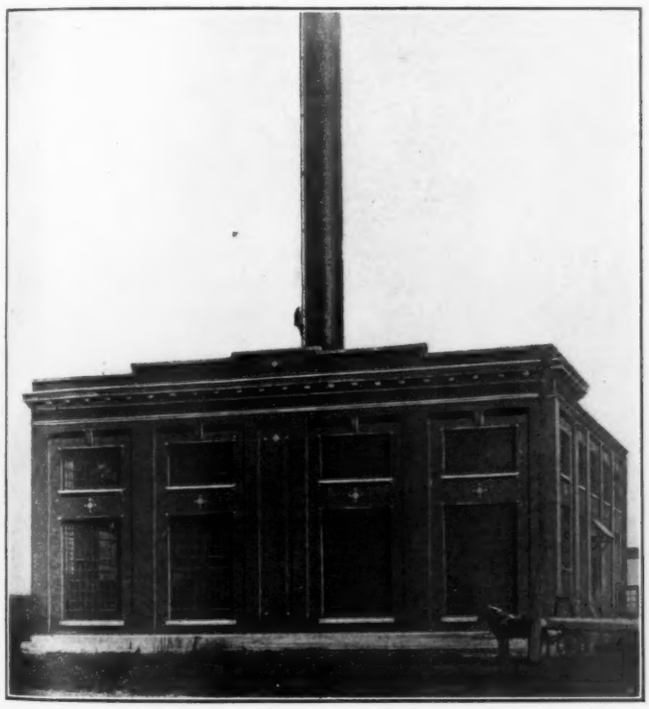
An inspection of the tools provided will show that this shop is prepared to make any class of repairs on its locomotives if necessary. The heavier tools are all grouped under the crane and are largely driven by individual motors, while the smaller tools are in most cases group driven. One of the tracks in the roundhouse served by the driver drop pit continues through the outside wall and for the full length of the machine shop. This permits the loading and unloading of heavy parts by means of the crane and also allows a locomotive to be drawn into the shop and the crane used for dismantling.

The shop is heated throughout by direct radiation, with the coils under the windows on the side walls. The roof is of four-ply slag roofing laid on ¾-in. sheathing.

Power House.—A structure which far exceeds in its architectural beauty anything usually associated with a locomotive terminal, encloses the power house at Orangeville. It consists of a practically square building of brick with granite footings and terra cotta trimmings, with a steel stack without stays located in almost the exact center. An extension on the rear of 31 ft. 9½ in. by 34 ft. 7 in. outside is provided for the boiler wash-

out equipment. The windows, which occupy a large portion of each panel, have steel sash. The structure has a steel framework, the center row of posts dividing it into two bays, one 35 ft. in width and the other 42 ft. in width, the latter being the boiler room and the former the engine room. Brick filling between these columns forms a wall between the two sections. Over the engine room there is a 10-ton crane furnished by Alfred Box & Co. Entrances are provided to the boiler washout section from both the engine and fire room and there is but one opening between the boiler room and engine room and this is provided with an underwriter's automatic fire door.

In the fire room there are installed three Sterling boilers, with a space left for another unit. The coal is brought in on the track alongside the northern wall and discharged on the floor in front of the boilers. The ashes fall into the basement, where there is an ash handling apparatus which discharges them into cars standing on the coal receiving track. The boiler feed pumps and feed water heater are located in the boiler room between the batteries of boilers and beside the stack foundation. There are nine 24-inch ventilators over the top of the boilers and five similar ventilators in the engine room. The foundation for the stack is a solid block of concrete 20 x 20 x 13 ft. brought up slightly above the floor level and to this the steel stack is bolted direct.



POWERHOUSE AT ORANGEVILLE.

In the engine room there is a 250 k. v. a. and a 100 k. v. a. Westinghouse generator, which furnish current at a pressure of 220 volts, 60-cycle. A 25-kw. steam turbine driven exciter is provided for starting the main aiternators, which afterwards receive their exciting current from a motor generator set. The air compressor is also located in the engine room.

Oil House.

A fireproof structure, brick walls on concrete foundations with steel roof trusses, is used for the oil house. Its main concrete floor is on a level with the platform along the track and the oil tanks are in a shallow basement below. The delivery faucets, of course, are in the main delivery room and air pressure is used to elevate the oil. The basement contains steam heating coils over the tanks and the arrangement for filling both from tank cars and barrels has been carefully worked out.

Coaling Station.

The coaling station, which is of timber construction throughout, is of the Holman-Barrett type as designed by Roberts & Schaefer Co., who erected it. The elevating equipment consists of a pair of 2½-ton Holman buckets and the distributing means consist of a pair of Barrett automatic distributing cars which work in time with the Holman buckets. The total storage capacity of the plant is 1,200 tons of coal and 100 tons of sand. Coal is received on two tracks with a receiving hopper under each. Both hoppers feed to the one pair of Holman buckets. Interposed between each hopper and the buckets is a pair of Barrett revolving measuring feeders so arranged that the buckets are taking coal from one hopper only at a time. The elevating buckets and distributing cars not only handle coal, but also handle the wet sand, delivering it into a large overhead bin. This bin has a concrete floor and underneath are two stove dryers in a fireproof compartment. The sand gravitates through the dryers over screens into hoppers underneath, from which it is elevated to three storage tanks overhead. These in turn deliver the sand to three tracks. There is also a compartment for coke and for hard coal. The plant is electrically operated and serves three tracks with coal and sand.

The water supply is obtained from the city and is pumped into two steel tubs, each of 50,000 gallons capacity, which furnish the pressure for the standpipes and general service. The boiler feed pumps, washout equipment, etc., draw their supply from these same tanks. There are fire hydrants located freely throughout the whole terminal, there being at least one in the immediate vicinity of every building.

Storehouse and Office Building.

This is a two-story structure with brick walls and wooden floors supported by iron columns. It contains the master mechanic's office, drafting room and storehouse. In the latter there is an elevator serving the basement and both floors, and a loading platform extends the full length of the building. Fireproof vaults of sufficient capacity to hold all valuable records are provided.

Adjoining the storehouse is a small brick structure which includes a large reading and rest room, communicating with the engineers' locker room, where expanded metal lockers of large capacity and in sufficient numbers have been installed for the convenience of train and shop men. Adjoining the locker room is a large wash and toilet room. The whole structure has concrete floors, excellent natural lighting and generally attractive surroundings.

THE LARGEST TELEPHONE EXCHANGE.—Plans are now being prepared for a telephone exchange to be used by the New York Telephone Company for its long-distance switchboard. The exchange will be the largest in the United States, and, it is believed, in the world. It will afford employment for 200 operators, and at the outset will have accommodation for 20,000 subscribers. The building is to be constructed to a height of 15 floors, but will ultimately be increased to 25 floors. When completed it will also provide for 60,000 local subscribers.

THE RAILWAY MILEAGE OF CANADA in 1910 was 24,731 miles, representing an increase for ten years of 6,591 miles; railways under construction, 4,500 miles; capital invested, $1,400,000,000, an increase over last year of $100,000,000, or an increase in ten years of $590,000,000. The number of passengers carried in 1910 was 35,894,570; tons of freight carried, 74,482,866, an increase in ten years of 37,483,495 tons; railway employees numbered 140,477, with a total annual pay roll of $73,000,000.

FOR THOSE WHO HAVE THE COURAGE to break away from some of the old traditions and conventional methods, there is an unlimited field. The difficulties are great, but the possibilities are greater. The results are conspicuously good.—*David Van Alstyne before the Congress of Technology, Boston, Mass.*

CLEAN COAL-TAR PITCH, free from water, acids, or soluble mineral matter, is the most efficient type of covering for iron pipes to prevent corrosion from contact with soil or electrolysis.

Locomotive Machine Efficiency

A. S. Williamson.*

Among the methods recommended for estimating the loss in tractive power due to the friction of locomotive drivers and their connected parts are the following:

R = 22.2 T, in which R represents resistance or loss in tractive power and T represents the total weight on the drivers, in tons. Recommended by the American Locomotive Company.

R = 22.65 T, or, when greater accuracy is required, the formula R = 18.7 T + 80 N may be used. In this N represents the number of driving axles. Proposed by the American Railway Engineering and Maintenance of Way Association.

In addition to these methods, the loss has sometimes been referred to the cylinders, by expressing it as equivalent to a certain loss in mean effective pressure. This figure may be substituted for the pressure factor in the common formula for tractive power, thus. $R = \frac{Pd^2s}{D}$, in which P is the frictional mean effective pressure, d the diameter of cylinder in inches, s the stroke, and D the diameter of the drivers, both in the same units.

In one series of tests with a small engine it was found that with a fixed cut-off the frictional M. E. P. was independent of the speed, but varied from 1.7 lbs. at 80 per cent. cut-off to 5.3 lbs. at 25 per cent. cut-off. When it is remembered that in working at the full power which is of interest in tonnage rating, cut-off varies inversely with (moderate) speeds, it follows that this variation with cut-off implies a variation in road service with speed. Again, the method assumes that losses are proportional to cylinder power, and it follows that two locomotives with the same size cylinders, but different weights on drivers, should have the same frictional loss. An examination of 69 modern locomotives of types ranging from Atlantic to Mallet,

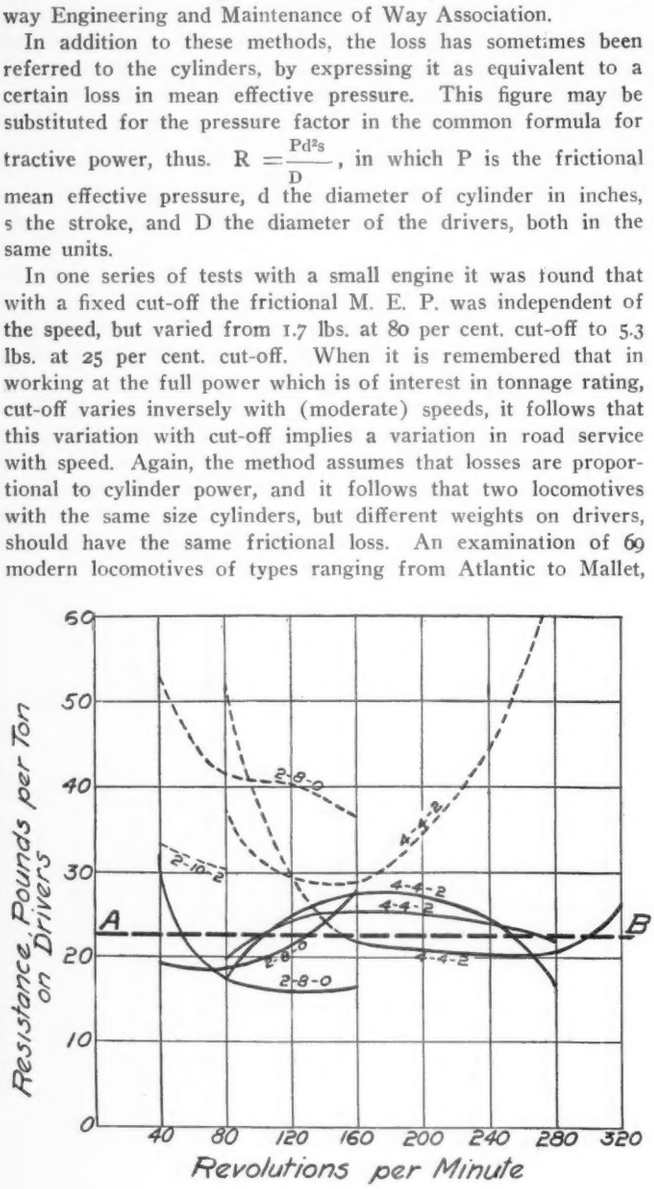


FIG. 1.

shows variations in the ratio of driver weight to tractive power of from 3.91 to 6. It is in this particular that the method differs from those based on driver weight, although the difference is slight and unimportant. Partly, perhaps, for this reason, but principally for the sake of simplicity, the latter is generally preferred.

Figure 1 represents graphically the resistance in pounds per ton on drivers, of all of the locomotives tested at St. Louis. Curves which, because of character of lubricant or which for other reasons are not comparable with the others, are dotted. The plotted points are not the results of individual tests which varied greatly, but are averages of all tests of each locomotive at the given speed. A few of the variations may be explained, but in road service such variations may be greater than on a testing plant. The diagram indicates that in the present state

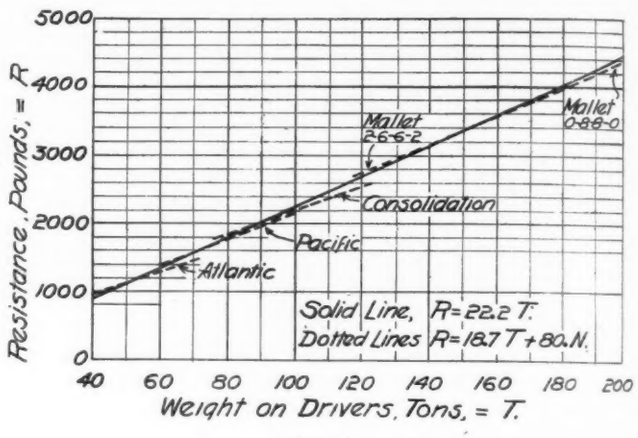


FIG. 2.

of knowledge of the subject, resistance may, without contradicting our data, be assumed as independent of speed. The formulæ R = 22.2 T and R = 22.65 T, are both represented by the line AB, since the scale of the diagram does not permit of the one being distinguished from the other. It is readily apparent that these rules may be derived by averaging, but this need not be done at this time, as the object in presenting the diagram is to point out the variations which occur even under laboratory conditions, and to show that refined or complicated methods of estimating resistance are unnecessary. This last statement may be illustrated as follows:

The rules R = 22.2 T and R = 18.7 T + 80 N were applied to the heaviest and to the lightest of eighteen miscellaneous modern consolidation locomotives, descriptions of which have recently appeared in the technical press. The maximum difference obtained by the two methods corresponded to a difference in tonnage rating of 1/8 of a 100,000 lb. load (gross). With Mallets the maximum difference was 1/7 of a load. With passenger locomotives, rated at sixty miles per hour, the differences varied between 1/42 and 1/3 of a 100,000 lb. coach. The differences in the results obtained where these two formulæ are applied to various types of locomotives, are shown graphically in Figure 2. In this figure the solid line represents a resistance of 22.2 lbs. per ton, and the dotted lines represent the formula R = 18.7 T + 80 N when applied to the types of locomotives indicated, throughout ordinary ranges of axle load. Bearing in mind the variations *in averages,* as shown by Figure 1, it becomes apparent that any such refinement as is offered by the longer formula is unnecessary.

Efficiency.

The variation in machine efficiency implied by the formula R = 22.2 T may be shown in the following manner:

In Bulletin No. 1001 of the American Locomotive Company tractive power curves based upon speed factors are given for a passenger locomotive of the following dimensions:

Cylinders	21½ x 26 in.
Boiler pressure	180 lbs.
Drivers, diameter	79 in.
Weight on drivers	54 tons

In the following table the approximate tractive effort indicated by those curves and which might be expected where there

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are no frictional losses, is given in column 3. In column 4 the figures in column 3 have been reduced by the amount of the driver loss given by the formula R = 22.2 T = 1,199 lbs. In the last column the efficiencies corresponding to these figures are given, and these are shown graphically by the crosses and

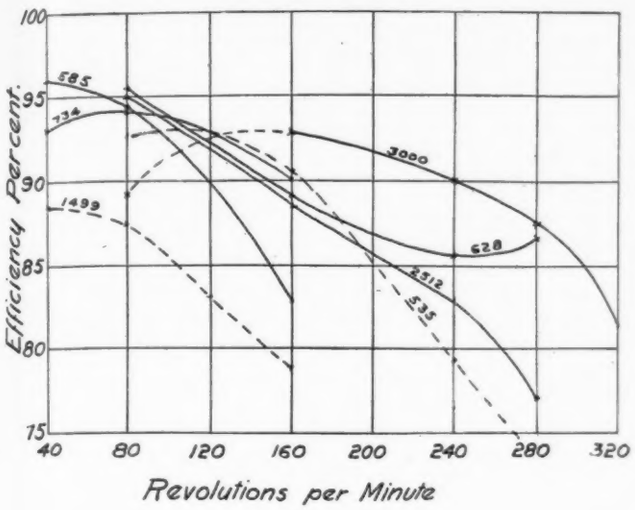

FIG. 3.

the upper curve, Figure 5. A similar curve of efficiency may be derived from the records of the St. Louis tests.

MPH.	RPM.	DBP. (Indicated).	DBP. (Friction Deducted).	Efficiency.
20	85	20,800	19,601	94.2
30	127	16,800	15,601	92.8
40	170	13,000	11,801	90.8
60	255	8,600	7,401	86.0

In the report of those tests certain diagrams are given which involve the assumption that frictional loss is independent of the percentage of power at which the locomotive may be working. Again, in working up certain results, it became apparent that journal friction constituted a large proportion of the total resistance. That the influence of draw bar pull on journal friction is slight may be seen from the fact that draw bar pull is but a fraction of the weight on drivers, and any small change in draw bar pull will result in but very slight changes in the resultant of these two forces at the journal. These and other similar considerations indicate that in calculating efficiencies for full load, the average frictional losses found in tests at part load may be used and will result in no serious error, and that this method may properly be used as an approximation when necessitated by the fact that no full power tests were made at slow speeds.

In Figure 3 efficiency curves for the St. Louis engines derived by this method are shown. The average loss at each speed is deducted from the maximum draw bar pull which the engine should have developed had danger of damage to the plant not prevented full power tests at slow speeds, and the result is divided by that maximum draw bar pull. In this figure the vertical

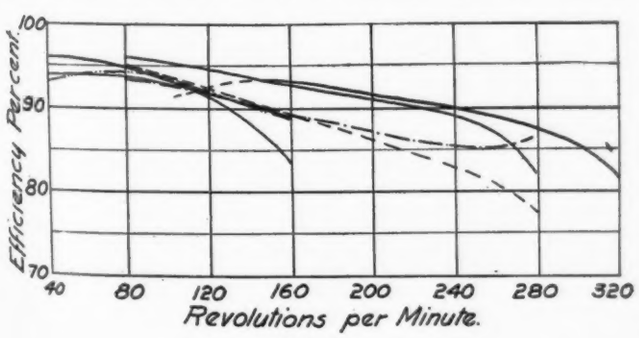

FIG. 4.

scale is enlarged for clearness. Tests with grease lubrication or tests which for other reasons are not strictly comparable with the others are dotted. The values for grease lubrication being raised to the probable equivalent with oil, the curves are shown to a normal scale in Figure 4. The various values for each speed being averaged, these averages are shown by the solid dots and lower line, Figure 5. The upper curve checks the assumption that the loss in tractive effort (not efficiency) is approximately independent of the exact percentagee of load. Or, accepting this, the lower curve checks the formula R = 22.2 T, which is the basis of the upper.

Were these two lines derived from the same engines and were the definition of "full power" the same in each case, the two should check, since averaging the efficiencies is but the equivalent of averaging the frictional losses, which latter it has been stated should result in approximately 22.2 lbs. per ton. However, in order to show the slight difference resulting from two methods of deriving these curves neither the engines nor the definition of "full power" is the same. In the upper curve full power is based upon the cylinders. In the lower it is based upon boiler capacities. Since, especially with small boilers or their combination with coal of low quality, the ability of the boiler to supply steam frequently limits the *sustained* tractive power at speed, a curve based upon boiler power may be expected to be lower than one based upon cylinder power. For this reason the lower line is suggested as preferable to the upper. Its equation through such ranges of speed as are of interest in rating is, *Efficiency* = 97. — .05 r.p.m.

Since ratios of driver weight to total weight of engine and tender vary enormously and since the resistances follow different laws, the formula can only apply to driver resistances. Truck, tender and air resistances must be separately taken care of by means of the usual train and air resistance formulæ. The formula cannot give absolute values for any one engine, but is offered as a close approximation to general machine efficiency at full power, and it may help to clear up some of the confusion which at different times has resulted from attempts to harmonize the conflicting efficiencies resulting from tests at indiscriminate loads.

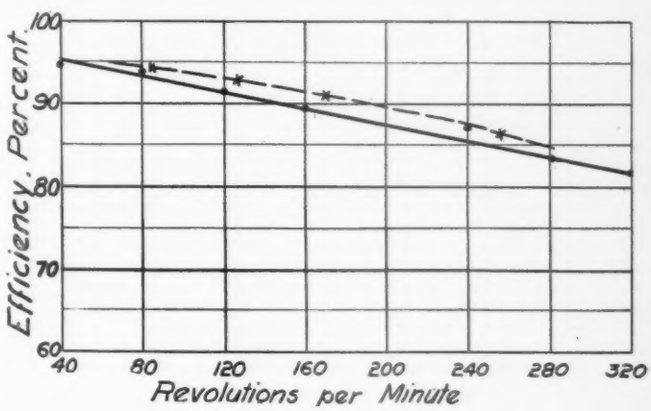

FIG. 5.

EXTENT OF TELEPHONE TRAIN DISPATCHING.—Although it is only about five years since the first railway train dispatching telephones were installed, there are to-day over 35,000 miles of railway operated by their use. These lines are in every sort of territory, from the densely populated with very heavy traffic to the deserts of the west. Eighty-nine per cent. of the Lake Shore and Michigan Southern's mileage is dispatched by telephone; 46 per cent. of the Michigan Central, 50 per cent. of the Big Four, 65 per cent. of the Lake Erie and Western and 100 per cent. of the Chicago Indiana Southern and Indiana Harbor Belt Lines. The Santa Fe has ordered equipment sufficient to equip over 4,600 miles of its line. About 20 per cent. of the Illinois Central is already so equipped. Practically all train movements on the Delaware, Lackawanna and Western are directed over the telephone. The Great Northern has over 1,500 miles of train dispatching telephone circuits, or about one-fourth of its total mileage. The Pennsylvania has considerably over 1,000 miles, about 20 per cent. of its lines.